He‘eia

National Estuarine Research Reserve

Management Plan 2016-2021

He‘eia National Estuarine Research Reserve
Management Plan
2016–2021

Prepared for:

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He‘eia National Estuarine Research Reserve

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A Traditional and Contemporary Approach

The Heʻeia NERR:
An Approach to Integrate Traditional Ahupuaʻa practices with the Contemporary NERRS Model to Sustainably Manage an Estuary

This plan for the proposed Heʻeia National Estuarine Research Reserve (Heʻeia NERR) presents an opportunity to honor the past by using the traditional ecosystem management approach embodied in ahupuaʻa principles, integrated with the contemporary principles of the National Estuarine Research Reserve System's (NERRS), to sustainably manage the Heʻeia estuary. The NERRS' vision of resilient estuaries and coastal watersheds where human and natural communities thrive is consistent with the traditional ahupuaʻa where man and the environment lived in harmony: the circle of life. Many of the objectives and strategies that have been built into this management plan intentionally create a link between traditional knowledge and practices with contemporary management plans. The unique niche of the Heʻeia NERR is this integration of traditional and contemporary strategies to sustainably manage the estuary and optimally the entire ahupuaʻa of Heʻeia. The Heʻeia NERR provides not only a model for future generations in Hawaiʻi but as important, is its contributions to the NERRS.

Ahupuaʻa: A Traditional Approach

"In the time of ʻUmi, son of the great chief Liloa, the Hawaiian Islands were divided into political regions. The four mokupuni (larger islands) of Kauaʻi, Oʻahu, Maui, and Hawaiʻi were divided into moku (districts)" (Kamehameha Schools 1994).

Each district was then divided into smaller self-sustaining communities called ahupuaʻa. The ancient ahupuaʻa were generally pie-shaped geographic units that often included entire valleys, which ran down between the mountain ridges that served as boundaries between adjoining ahupuaʻa, to the outer edge of the reef in the sea. Each ahupuaʻa also included a stream that defined the watershed (Figure 0-1). These ahupuaʻa varied in size on different islands, from as small as 100 acres to as large as 100,000 acres. The word ahupuaʻa is derived from ahu, an altar of stones, upon which was placed an image of the head of a puaʻa (pig). The altars marked the boundaries between each ahupuaʻa.

The upland forest was called the wao akua, the realm of the gods. There, the trees and forest were the physical manifestation of the spiritual world, and only a few were permitted to enter wao akua. As the water flowed through the wao akua, it would enter the wao kanaka, or the realm of man. This referred to the area that sustained the agriculture, aquaculture, and other human activities (Stewart 2003). From wao kanaka, the water would flow out to the sea, and in many instances through the loko iʻa (fishpond).

The ahupuaʻa contained nearly all of the resources Hawaiians required for survival. Freshwater resources were managed carefully for drinking, bathing, and irrigation. Wild and cultivated plants provided food, clothing, household goods, canoes, weapons, and countless other useful products.

The ahupuaʻa system was a traditional land management system designed to protect the upland water resources as they flowed to the ocean. The konohiki (overseer, or headman of an ahupuaʻa land division under the chief) managed land use, assisted by luna (supervisors) who were experts in different specialties. For example, the luna wai (water master) was in charge of the water for the loʻi (irrigated terraces), and another luna was in charge of the land boundaries within the ahupuaʻa. Each ahupuaʻa also had its own master fisherman and master farmer. The konohiki would manage the ahupuaʻa through the kapu (taboo) system, which placed restrictions on fishing certain species during specific seasons, on gathering and replacing certain plants, and on many aspects of social interaction, to ensure that the community maintained a sustainable lifestyle in harmony with the resources.

Within the ahupuaʻa, the stream was among the most important natural resources to be managed. The Hawaiian word for fresh water is wai and the Hawaiian word for wealth, abundance, and prosperity is waiwai. Water was considered such a sacred resource that, in ancient times, battles were fought for the right to use streams, and the lives of those who abused this right were sacrificed. People took only what water they needed from the stream and were severely punished if they took more than they needed. In fact, the Hawaiian word for law is kānāwai, meaning the equal sharing of water.

> The ahupuaʻa embodies a unique relationship between the Hawaiian people and land as well as the practical and rational approaches applied to insure the sustainability of the natural environment from overexploitation, pollution and extinction. According to ancient folklore (moʻolelo), the islands and its people were born of the spirit world by gods Papa (the earth) and Wakea (the sky). As such, they share a common origin as living entities. As a living entity, the land is viewed by the Hawaiians as a woman who gave birth to and nurtured the Hawaiian people and whose bosom we will return to upon death. This unique "circle of life" relationship illustrates an inherent symbiotic existence between man and the land. The proverbial Hawaiian saying, "if you care for the land, the land will care for you," typifies this timeless relationship. (Blane and Chung 2000)

The basic principles of the ahupuaʻa are as follows (Blane and Chung 2000):

- Kai Moana: Preserve all life in the ocean extending from the shoreline to the horizon
- Makai: Respect the land and resources extending from the shoreline to the sand's reach
- Mauka: Respect all land and resources from the sand's edge to the highest mountain peak
- Kamolewai: Respect all water resources, including rivers, streams, and springs and life within

- Kanakahonua: Preserve and respect the laws of the land and each other to ensure the community's health, safety, and welfare
- Kalewalani: Respect the elements that float in the sky, including the sun, moon, clouds, stars, wind, and rain, which guide the planting and fishing seasons, provide water, and create the tides and directions for ocean navigation
- Kapahelolona: Preserve the knowledge of practitioners
- Keʻihi: Preserve and respect the sacred elements, including deities, ancestors, the forces of nature, and ceremonial activities

Kumu John Kaʻimikaua (2000) described the weaving of the ʻaha cord as the braiding of these eight principles. Alone, each strand is weak, but together they form a strong rope.

Blane and Chung (2000) assert that ahupuaʻa, in practice, is really about (1) instilling appropriate values that allow people to make the right choices for not only themselves but society; (2) making community-based efforts in which ahupuaʻa tenants, people with localized knowledge, and people with a personal stake in their ahupuaʻa are involved in decision making; (3) creating partnerships and involving stakeholders who, when united, can examine existing western governmental and legal structures and weave the ahupuaʻa principles throughout; and (4) perpetuating this practice from generation to generation.

The National Estuarine Research Reserve System (NERRS): A Contemporary Approach

The NERRS was founded on the principle that long-term protection of representative estuaries provides stable platforms for research and education and the application of management practices that will benefit the Nation's estuaries and coasts. Individual NERRs serve as living laboratories for the study of estuaries and natural and man-made changes. NERRs employ place-based approaches to connect science to people, whether they are teachers, students, decision makers, or coastal residents. It is the integration of locally relevant programs with System-wide approaches that fosters innovation and allows comparison of estuarine conditions across the country. Trusted long-term relationships with local communities, state and federal agencies, and other non-governmental entities form partnerships that amplify the impact of individual NERRs and the system. The influence of NERR programs and products are felt well beyond the boundaries of individual sites.

The NERRS is guided by several principles (NERR Strategic Plan 2011-2016):

- Engage local communities and citizens to improve stewardship of coastal resources;
- Create strong partnerships to enhance the success of Reserve programs;
- Integrate research, education, and stewardship to address complex coastal problems;
- Implement best management practices (BMPs) at reserves to lead by example;

- Seek regional collaborations to extend the influence of reserve programs and products.

The Vision of the NERRS is: Resilient estuaries and coastal watersheds where human and natural communities thrive. The Mission of the NERRS is: To practice and promote stewardship of coasts and estuaries through innovative research, education, and training using a place-based system of protected areas.

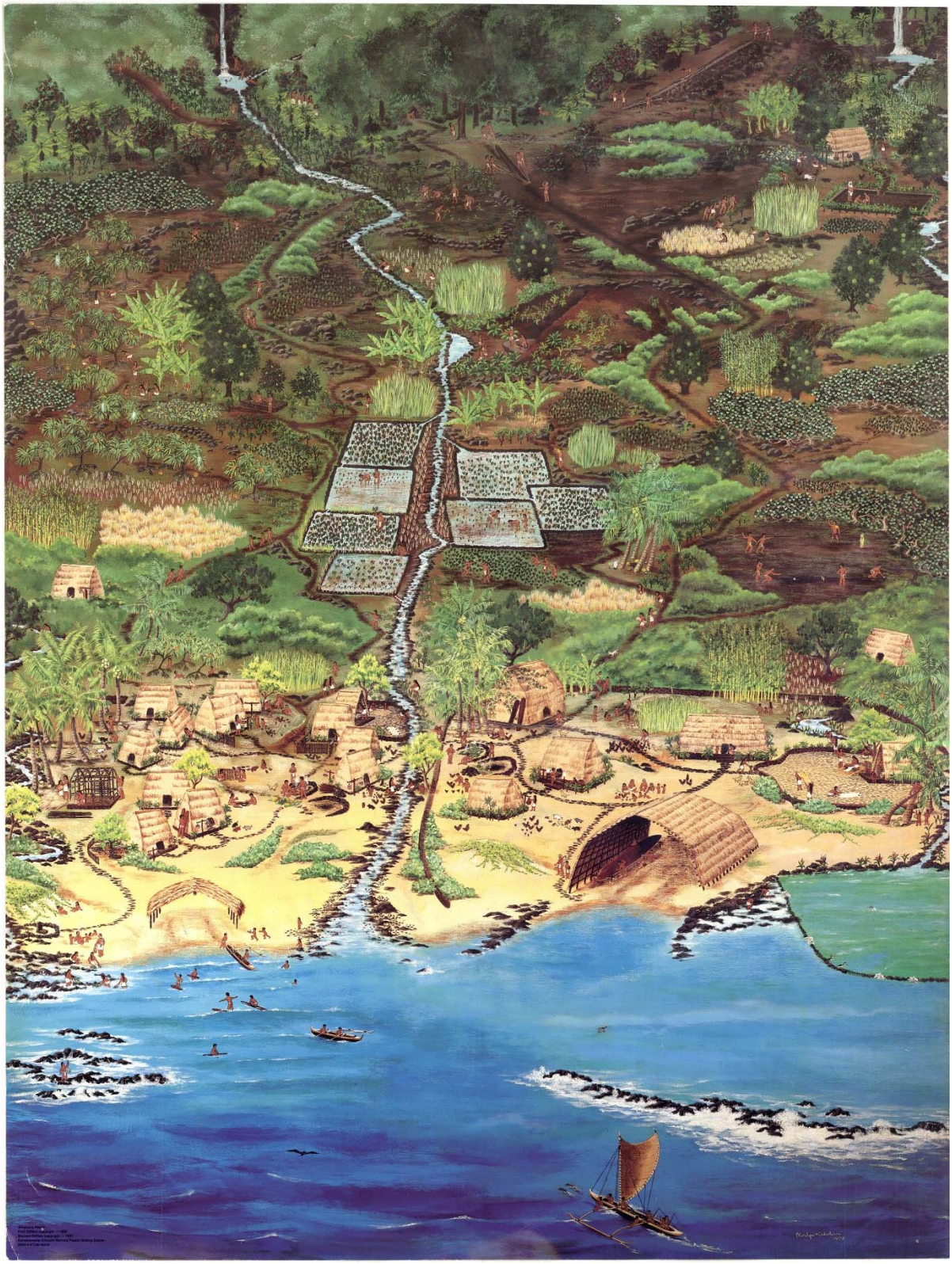

Figure 0-1. The Ahupua‘a – Life in Early Hawai‘i

Artist Marilyn Kahalewai

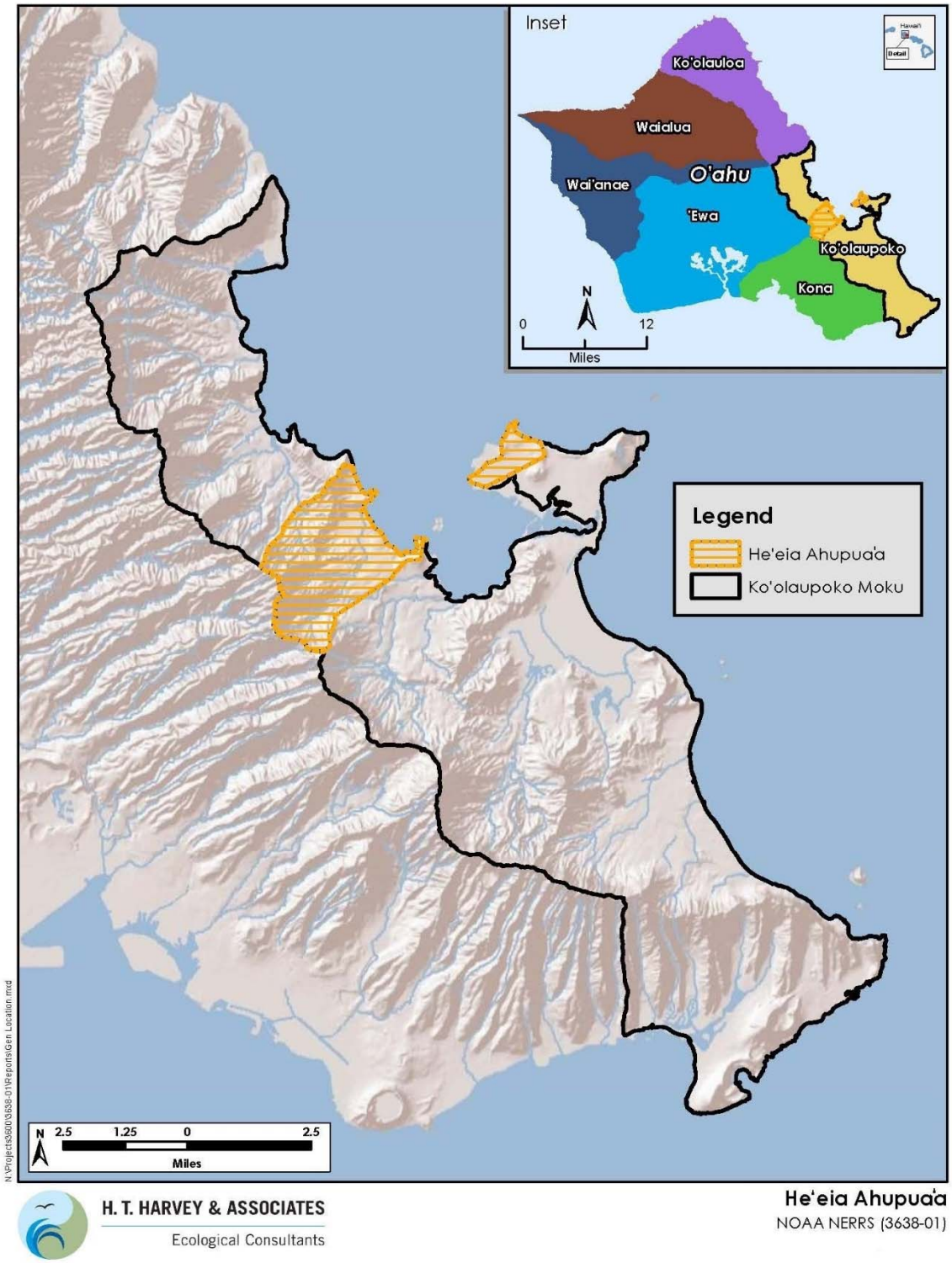

Figure 0-2. The Ahupua‘a of He‘eia, Located in the Ko‘olaupoko Region of O‘ahu

Acknowledgements

First of all, we would like to acknowledge the original stewards, the kūpuna (ancestors) of this land, native Hawaiians, who managed the ʻāina (land) and kai (ocean) resources sustainably through the ahupuaʻa (traditional land stewardship) practices and values.

We would also like to acknowledge the current active stewards of the ʻāina and kai who have been instrumental in pursuing the designation of the Heʻeia estuary as a National Estuarine Research Reserve (NERR). These site partners include the Koʻolaupoko Hawaiian Civic Club, Koʻolau Foundation, Kakoʻo ʻŌiwi, Paepae o Heʻeia, Hawaiʻi Institute for Marine Biology, and the Heʻeia State Park. They unconditionally shared their stories, experiences, and knowledge about the ahupuaʻa of Heʻeia and Kāneʻohe Bay which laid the foundation for the Strategic Plan and management plan. They also provided valuable manaʻo (comments) at the public meetings and on the draft management plan. We are grateful for their time and dedication.

Besides the site partners, there were many other community members who participated in public meetings or provided written comments. We have greatly appreciated the advice, comments, and recommendations provided by our federal partners at the National Oceanic and Atmospheric Administration (NOAA) Office for Coastal Management Stewardship Division Ecosystem and NERRS Program and the Pacific Islands Region. They attended the numerous public meetings, focus group meetings, and Steering Committee meetings and provided insightful comments to ensure consistency and compliance with the NERRS program.

Finally, it is our kākou (collective) hope that through the implementation of the Heʻeia NERR management plan and commitment by not only the current stewards of the land but the greater community, that the ahupuaʻa of Heʻeia and in particular the Heʻeia estuary will be the ʻāina momona (abundant) legacy for future generations. In the spirit of its legacy, we want to acknowledge the future generations who will continue the stewardship of this ʻāina and kai.

Executive Summary

A Community-Driven Plan

The ahupuaʻa of Heʻeia has a long history of stewardship by Native Hawaiians based upon the traditional ahupuaʻa principles and currently by several of the site partners who have recognized the wisdom and value of the old ways. The community discussed the benefits of greater collaboration and coordination amongst themselves but also the benefit of being part of the larger NERRS. For too long, the site partners struggled independently with limited financial resources and scientific information about the challenges affecting their own geographic areas, including impacts of the overgrowth of mangroves in the Heʻeia fishpond, impacts of upland sedimentation on the stream water quality that nourished the loʻi kalo (taro patches), impacts of the invasive algae on the health of the coral reefs within Kāneʻohe Bay, and ultimate impacts of a rising sea level on Heʻeia State Park.

Through the collective efforts of the site partners and the State of Hawaiʻi, through the Office of Planning (OP), designating the Heʻeia estuary as a NERR was determined to be an appropriate means to address some of their local challenges by partnering with the National Oceanic Atmospheric Administration (NOAA). The Heʻeia NERR was viewed as an opportunity for these site partners to collaborate and constructively coordinate their activities to im prove the entire land and water area associated with the ahupuaʻa of Heʻeia.

The site partners, OP, and NOAA over the last several years have dedicated time and resources to engage the community, balance the impacts of a NERRS designation, and commit to meeting regularly to pursue the NERRS designation process. This management plan reflects not only the site partners' but the larger community's support for a plan to more effectively and efficiently manage the Heʻeia estuary in a culturally appropriate way that builds upon traditional knowledge and contemporary science. The Heʻeia NERR provides an opportunity for coordinated management of resources to collectively achieve not only local goals but the larger goals of NERRS. This Heʻeia NERR management plan[1] starts with "A Traditional and Contemporary Approach," which seeks to integrate traditional knowledge of the ahupuaʻa and contemporary scientific research, monitoring, and training. The placement of the Approach at the beginning of the management plan was deliberate to provide the reader and user of the management plan an understanding and appreciation of the connection between traditional knowledge and contemporary science and research as a model for a sustainable estuary.

[1] In drafting the Heʻeia NERR management plan, the Office of Planning utilized NOAA's 2013 Reserve System Management Plan Guidelines and Resources for guidance. However, there are some very unique features of the Heʻeia NERR that deviate from the standard guidelines, specifically the emphasis on Native Hawaiian Cultural values and practices (as described in the "A Traditional and Contemporary Approach" section) and Community Engagement (see Section 2). It is these unique features that contribute to the Heʻeia NERR's niche within the NERRS.

Management Plan Purpose and Scope

The He‘eia NERR management plan is based on an adaptive management strategy; in other words, as more information becomes available, this management plan may be amended to adapt to the new information through annual and 5-year reviews. The site partners were very deliberate in emphasizing that one of the priority objectives is to develop adequate baseline data; this would include oral and archival information on traditional information when the ahupua‘a of He‘eia and streams were healthy and sustained a productive agricultural and aquacultural environment. The baseline data collection would also include the current conditions of the He‘eia NERR, including water quality, coastal ecosystems, coral habitats, and aquatic species within the streams for both the core and buffer areas. The baseline information will set the foundation upon which to evaluate impacts of human and natural elements, including climate change, and if necessary alter the management objectives and strategies to improve management. Monitoring programs will also provide critical information on impacts of restoration and manipulation activities within and outside the He‘eia NERR.

The adaptive management approach will also assist the He‘eia NERR staff and reserve advisory board (described in Section 5.5.1) to more effectively assess and evaluate staffing, facilities, and program needs. The information gathered will provide the NERRS with critical information related to coastal communities, water quality, and climate change.

Site Nomination Context

The State of Hawai‘i, through OP, has coordinated with NOAA to nominate the He‘eia estuary as a NERR. Since 1972, NOAA has designated 28 NERRs as part of the system. In 1978, Waimanu Valley on the windward coast of Hawai‘i Island was designated as the first NERR in the State of Hawai‘i. However, because of several issues, including the site’s inaccessibility and the lack of a final management plan, the Governor of Hawai‘i requested that the site be de-designated in 1993. Since then, the State has continued to be interested in participating in the NERRS program, because Hawai‘i could benefit from the designation as well as contribute to the NERRS.

Accordingly, on May 21, 2014, Governor Abercrombie officially nominated He‘eia as a NERR to support NOAA’s policy to encourage expansion of the program in unrepresented areas of the country. In particular, the State believes that the designation of He‘eia could contribute to the objectives of the NERRS by addressing the research, education, and natural resource stewardship goals of the system. Unlike the previously designated site in Hawai‘i, He‘eia is easily accessible to researchers, educators, and the public. More importantly, the nomination received the broad-based support of the Native Hawaiian community, represented by the Ko‘olaupoko Hawaiian Civic Club (KHCC) and current managers of the estuary, including Paepae o He‘eia and Kako‘o ‘Ōiwi. Likewise, the University of Hawaii’s (UH) Hawai‘i Institute of Marine Biology (HIMB), located at Moku O Lo‘e, has conducted extensive research in the area and has the management infrastructure to lead the He‘eia NERR, once it is designated.

Site Overview

The He‘eia NERR is located on the northeastern or windward shore of the island of O‘ahu. The site includes He‘eia State Park, He‘eia Fishpond, He‘eia wetlands, a large expanse of marine waters with patch and fringing reefs, as well as Moku o Lo‘e (Coconut Island). The total acreage of the He‘eia NERR is approximately 1,385 acres. The habitat types represented in this He‘eia NERR include both aquatic and terrestrial areas: coral reefs and open marine waters, the enclosed He‘eia Fishpond, mangrove stands, landscaped areas on Moku o Lo‘e and at He‘eia State Park, taro patches and gardens, overgrown wetland marshes, seasonally wet grasslands, and He‘eia Stream.

The State partner for the He‘eia NERR will be UH‘s HIMB. HIMB will work with other landowners and managers, as well as other members of the Reserve Advisory Board (RAB) to coordinate management decisions within the He‘eia NERR.

Coastal Management Issues and Reserve Goals

There are a number of priority coastal management issues for the He‘eia NERR which are consistent with local and national coastal management needs and priorities. These issues include a number of natural processes and anthropogenic effects: invasive species, loss of habitat, erosion and sedimentation, nonpoint source pollution, urbanization and human activities in the area, water quality issues, agricultural development, and climate change impacts on the area. Monitoring the effects of different management strategies on the ecosystem services provided by the areas within the He‘eia NERR will offer insights into adaptive management decisions that will support the health of the ecosystem.

The goals, objectives and strategies in the He‘eia NERR management plan are linked to proposed outcomes that can be used to measure progress or success in accomplishing the objectives. The management plan is specifically designed to bridge the state Coastal Zone Management Ocean Resources Management Plan (ORMP) priorities and NOAA’s mission of science, service, and stewardship with locally relevant issues in He‘eia.

Reserve Niche

From a cultural perspective, the He‘eia NERR provides a unique opportunity to integrate traditional ahupua‘a practices with contemporary scientific research and knowledge to sustainably manage the He‘eia estuary. Historically, the ahupua‘a of He‘eia was managed as a traditional ahupua‘a which nurtured the Native Hawaiian community in abundance while also maintaining a healthy watershed and ecosystem (Blane and Chung 2000).

There are a number of programs and projects already in place in the area that complement the mission of establishing the He‘eia NERR. For example, a number of ongoing research projects are being conducted in the area on critical issues such as invasive species, coral reef resilience to climate change, habitat and water quality, and the effects of traditional agricultural practices on downstream conditions (See Section

4.1 Research and Monitoring Program). Educational activities in the area, including ecotours of Kāneʻohe Bay and hands-on activities at the Fishpond and taro patches, offer visitors an upclose experience of the estuary. Stewardship activities such as the removal of invasive species help to restore the estuary to a natural representative state. The rehabilitation of the historic Heʻeia Fishpond and cultivation of taro and other crops using traditional methods support the use of a traditional land use system.

Further, as part of the NERRS network, the Heʻeia NERR is uniquely situated as the sole representative of the Pacific region, and can contribute to a better understanding of island estuaries and coral reef systems. The need for knowledge is urgent, given that many island communities around the world, including those in the Pacific, are feeling the impacts of climate change intensely and immediately.

Reserve Programs Overview

Research, Education and Stewardship

The three foundational programs of the Heʻeia NERR include research, education, and stewardship. Each of these program goals have incorporated the unique niche of Heʻeia and local and national coastal management issues and goals.

The NERR System-Wide Monitoring Program (SWMP) will provide long-term data useful to the research conducted in the Heʻeia NERR, including water quality, weather, habitat, and land-use data. The priority goal under Research and Monitoring is to promote contemporary research and traditional knowledge to increase our understanding of the effects of human activities and natural events (including climate change) to improve informed decision making affecting the Heʻeia estuary and coastal resources. Considering and incorporating traditional knowledge will help to strengthen the research done in the Heʻeia NERR by considering historical land use and manipulation, and its effects on the estuarine environment including the ecosystem services these activities provide. This goal is consistent with the State's Coastal Zone Management's ORMP Priority 1: "Connecting Land and Sea." The ORMP's priorities are aligned with NOAA's priorities. Additionally the NOAA-funded Science Collaborative competitive grant program integrates science end-users into the research process. Heʻeia NERR staff, supported by HIMB, will support relevant research and ensure researchers are aware of relevant traditional knowledge resources that may complement their research projects. Linking research products to end users is another role the Heʻeia NERR staff will play.

The Heʻeia NERR Education Program will include the hands-on, field-based workshop Teachers on the Estuary (TOTE) program and the K-12 Estuary Education Program (KEEP). HIMB provides a full spectrum of formal and informal educational opportunities for all types of participants along the learning continuum. A central mission is to create pathways to marine science research and management careers for students from Hawaiʻi school systems. Site partners such as Paepae o Heʻeia and Kakoʻo ʻŌiwi each have their own place-based knowledge and ecological-based education programs. The priority goal under the Education

Program is to develop place-based education and training programs for the He‘eia NERR that inspire and educate the community about estuaries, coastal ecosystems, and traditional Hawaiian practices. This is consistent with ORMP Priority 2: “Preserving Our Ocean Heritage.”

The He‘eia NERR Stewardship Program seeks to support activities that involve the community’s active engagement in management of the He‘eia NERR. The priority goal under the Stewardship Program (also referred to as Public Outreach and Resource Management)[2] is to engage the various communities to create opportunities for greater stewardship that sustains cultural, biological, and natural resources. This is consistent with ORMP Priority 3: “Promoting Collaboration and Stewardship.” Encouraging the use of the He‘eia NERR’s monitoring data and research findings, educational products and informational outreach materials is an important step in linking the He‘eia NERR to the land managers, the public, and local decision makers.

He‘eia NERR Administration Plan

Administration of the He‘eia NERR, like other NERR sites, will be accomplished through a federal, state, and local partnership. At the federal level, NOAA may provide funding, based on appropriations, as well as program guidance and oversight. NOAA shall conduct periodic evaluations to ensure implementation of the management plan and consistency with the NERRS goals and objectives. A Memorandum of Understanding (MOU) between HIMB and NOAA establishes the roles and responsibilities of both agencies (Appendix J). In Hawai‘i the state partner shall be the UH ’s HIMB. HIMB will coordinate with site landowners and land managers as well as other state agencies for the day-to-day management of the site. A Multi-Party Governance Charter between HIMB and landowners and partners will establish the roles and responsibilities of these partners (Appendix K).

The He‘eia NERR has facilities that will be made available upon the He‘eia NERR designation for NERR program needs. As the He‘eia NERR develops during its first 5 years of operation, interim facilities will likely need to be improved or expanded to adequately meet growing program needs. Items like dedicated office space, additional storage, expanded laboratory and educational facilities, and increased community meeting space may be needed. However, to a large extent, the addition of any facilities beyond what the current site partners have available will be dependent on the availability of financial resources.

The initial staffing needs will include a full-time Reserve Manager, Education Coordinator, Research Coordinator. The He‘eia NERR management plan also recommends the hiring of a Stewardship Coordinator and Cultural Resource Coordinator since Native Hawaiian values and practices are an integral part of the He‘eia NERR. These staff members will develop and manage NERR programs led by HIMB.

[2] As previously noted in footnote 1, although the He‘eia NERR management plan seeks to be consistent with NOAA’s 2013 guidelines, during the community engagement process (specifically the focus group meetings), the Stewardship Program was referred to as Public Outreach and Resource Management. Thus, the meeting notes contained in Appendices F and G may refer to training aspects or stewardship activities in the He‘eia NERR as Public Outreach and Resource Management, but they are one and the same.

As funding or partnership opportunities become available, there will be additional staff required within the first five years, to meet the management plan goals and objectives. The staffing positions could be full-time, part time, or internships with capacities or expertise in the following areas: outreach or stewardship coordinator, training coordinator, research assistant, technical positions to implement and monitor the NERR SWMP, and technical assistant.

He‘eia NERR Land Acquisition

Currently, the He‘eia NERR contains only the makai or lowland portions of the ahupua‘a of He‘eia which met the site selection criteria established by OP and NOAA. The site selection criteria includes having the support of the landowner for its inclusion in the He‘eia NERR, having adequate state control over the property, and being a good representative estuarine ecosystem suitable for long-term estuarine research, education and interpretive efforts. One of the long-term visions of the community is to expand the boundaries to include more of the mauka or upland areas of the watershed. Another possible expansion for the He‘eia NERR is the forested area above He‘eia Kea Small Boat Harbor.

He‘eia NERR Resource Manipulation and Restoration Activities

The Resource Manipulation section (Section 10) describes activities such as agriculture and aquaculture. One of the primary goals of the site partners through the He‘eia NERR is for the ahupua‘a of He‘eia to be restored and managed as a traditional ahupua‘a with functioning agricultural and aquacultural systems. The current resource manipulation activities being conducted in the He‘eia NERR buffer area include the conversion of currently fallow lands in the He‘eia wetlands into a working agricultural landscape with organic lo‘i kalo and organic dryland agricultural crops and aquaculture activities in He‘eia Fishpond.

The He‘eia NERR management plan includes a description of the current resource restoration activities conducted by site partners and government agencies. The Resource Restoration section (Section 11) outlines the current restoration activities conducted in the He‘eia NERR buffer areas including invasive species removal in the wetlands and along He‘eia stream conducted by Kako‘o ‘Ōiwi, invasive seaweed removal by Paepae o He‘eia, and coral reef restoration conducted by the Department of Land and Natural Resources (DLNR) Division of Aquatic Resources (DAR).

Protection and Preservation of Valued Cultural, Historical, and Natural Resources, Including Native Hawaiian Traditional and Customary Rights

The State of Hawai‘i has a constitutional obligation to preserve and protect, to the extent feasible, traditional and customary rights exercised by Native Hawaiians. The State recognizes that the ahupua‘a of He‘eia is a living resource where Native Hawaiians exercise traditional and customary practices, either within the He‘eia NERR or within the ahupua‘a of He‘eia, to which the He‘eia NERR may provide access. With this recognition comes the obligation to preserve and protect those constitutionally guaranteed rights. The Hawai‘i Supreme Court, in its decision in Ka Pa‘akai O Ka ‘Āina v. Land Use Commission, 94 Hawai‘i 31, 7 P.3d 1068 (2000), provides government agencies an analytical framework to ensure the protection

and preservation of valued cultural, historical, and natural resources. This management plan addresses this requirement as follows:

1. The management plan identifies the valued cultural, historical, and natural resources on the He‘eia NERR site. Section 1 provides an archival review of the available biological and ecological documentation, research, cultural impact assessments, and archaeological reports of the area.

2. The management plan describes threats and impacts to these valued cultural, historical, and natural resources on the He‘eia NERR site. Generally, threats consist of the impacts on the free flow of He‘eia Stream caused by overgrowth of vegetation, adverse effects on endangered waterbirds resulting from the proliferation of mangroves, and impacts on downstream water quality caused by runoff from uplands.

3. The third step in the Ka Pa‘akai analysis is the “feasible actions” or in this case the management plan sets forth the management goals, objectives, and strategies to be taken by the He‘eia NERR administrators and site partners to reasonably protect these valued resources or access to these resources. The management actions, developed through the community engagement process, seek to integrate the traditional land stewardship principles of the ahupua‘a and contemporary scientific research and investigation.

In developing the He‘eia NERR management plan, the State accepted the kuleana (responsibility) of developing a management plan that was: (1) based on community engagement, (2) built on the extensive archival studies and research previously conducted in the area, and (3) proposes reasonable management objectives. Throughout the community engagement process, it was apparent that the community stakeholders have been diligently stewarding their lands, managing their resources, and building a wealth of information, but these activities could be strengthened with additional communication and collaboration with other stakeholders. The He‘eia NERR provides an opportunity not only to weave together the cultural and ecological perspectives but also to support a kākou (collective) effort to share information, maximize limited resources, and manage the entire He‘eia estuary in a sustainable way.

Table of Contents

Figures

Tables

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He‘eia State Park, Holokai Kayak & Snorkel Adventures
H. T. Harvey & Associates Ecological Consultants
Kāko‘o ‘Ōiwi
Ko‘olaupoko Hawaiian Civic Club
Paepae o He‘eia
Source for maps in the documents include Hawai‘i Office of Planning, State GIS Website, and conservation plans produced by Townscape (2011a and b).

Acronyms and Other Abbreviations

Abbreviation	Meaning
BMPs	best management practices
CDD	Community Development District
CFR	Code of Federal Regulations
CIA	cultural impact assessment
CRAMP	Coral Reef Assessment and Monitoring Program
CWA	Clean Water Act
CWB	Clean Water Branch, DOH
CZM	Coastal Zone Management
CZMA	Coastal Zone Management Act
DAR	Division of Aquatic Resources, DLNR
DBEDT	Hawai‘i State Department of Business, Economic Development and Tourism
DHHL	Department of Hawaiian Homelands
DLNR	Hawai‘i State Department of Land and Natural Resources
DOBOR	Division of Boating and Ocean Recreation, DLNR
DOCARE	Division of Conservation and Resource Enforcement, DLNR
DOFAW	Division of Forestry and Wildlife, DLNR
DPP	Department of Planning and Permitting
EA	environmental assessment
EBM	ecosystem-based management
EIS	environmental impact statement
EMD	Environmental Management Division
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
GIS	Geographic Information Systems
HAR	Hawai‘i Administrative Rules
HCDA	Hawai‘i Community Development Authority
HEPA	Hawai‘i Environmental Policy Act
HIDOH	Hawai‘i Department of Health
HIMB	Hawai‘i Institute of Marine Biology

HPD	Honolulu Police Department
HRS	Hawai‘i Revised Statutes
ICI	invertebrate community index
KEEP	K-12 Estuarine Education Program
KMWP	Ko‘olau Mountains Watershed Partnership
KHCC	Ko‘olaupoko Hawaiian Civic Club
NEPA	National Environmental Policy Act
NERR	National Estuarine Research Reserve
NERRS	National Estuarine Research Reserve System
NH3	ammonia-nitrogen
NMFS	National Marine Fisheries Service
NO_3+NO_2	nitrate+nitrite-nitrogen
NOAA	National Oceanic and Atmospheric Administration
NOP	National Ocean Policy
NPO	National Priority Objectives
NSF	National Science Foundation
NWI	National Wetland Inventory
MOU	Memorandum of Understanding
OCCL	Office of Conservation and Coastal Lands, DLNR
OP	Office of Planning, State of Hawai‘i
ORMP	Ocean Resources Management Plan
PRCP	Polluted Runoff Control Program
RAB	Reserve Advisory Board
SEC	Site Evaluation Committee
SES	Social-Ecological System
SHPD	Hawai‘i State Historic Preservation Division, DLNR
SMA	Special Management Area
SOEST	School of Ocean and Earth Science and Technology
SSC	Site Selection Committee
TCP	Traditional Cultural Properties
TMDLs	total maximum daily loads
TMK	Tax Map Key (Number to identify real property unit)
TN	total nitrogen
TP	total phosphorus
TSS	total suspended solids

UH	University of Hawai‘i
USACE	United States Army Corps of Engineers
USC	United States Code
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
ZCTA	Zip Code Tabulation Area (U.S. Census equivalent of Zip Code area)

Glossary of Hawaiian Words

The Hawaiian translations are from Pukui and Elbert (1986). For some of the words a more contemporary meaning may be used by Hawaiians today; for these words they are placed before the Pukui and Elbert (1986) translations and marked with "(common)."

The ʻokina and the kahakō are diacritical markings that are part of the Hawaiian alphabet and used in the Hawaiian words. The ʻokina, or glottal stop, is found only between two vowels or at the beginning of a word that starts with a vowel. A break in speech is created between the sounds of the two vowels. The pronunciation of the ʻokina in the word Kākoʻo is similar to saying "ka-koh-oh." The kahakō is found only above a vowel. It stresses or elongates a vowel sound from one beat to two beats. The kahakō is written as a line above a vowel. There are differing pronunciations of some words depending on the area or island.

Hawaiian Word	English Translation
ʻaha moku	A system of best practices based on indigenous resource management practices within specific moku (district) boundaries to sustain resources and the community of that moku. A series of district councils that would manage land and natural resources for tenants and the community through the implementation of site specific cultural conservation coupled by utilitarian practices.
ahu	Altar of stones (common).
ahupuaʻa	Land division usually extending from the uplands to the sea, so called because the boundary was marked by a heap (ahu) of stones surmounted by an image of a pig (puaʻa), or because a pig or other tribute was laid on the altar as tax to the chief.
ʻāina	Land.
aliʻi	Chief, chiefess, officer, ruler, monarch, peer, headman, noble, aristocrat, king, queen, commander.
ʻamaʻama	Mullet (*Mugil cephalus*), a very choice indigenous fish.
ʻāpana	Piece, slice, portion, fragment, section, segment, installation, part, land parcel, lot, district, sector, ward, precinct.
ʻaumakua	Family of personal gods, deified ancestors who might assume the shape of sharks, owls, hawks [etc.]. A symbiotic relationship existed; mortals did not harm or eat ʻaumakua, and ʻaumakua warned and reprimanded mortals in dreams, visions, and calls. Aumākua—plural of ʻaumakua.
ʻauwai	Ditch, canal, water conveyance channels.
ʻawa	Kava (*Piper methysticum*).
awa	Milkfish (*Chanos chanos*).
haʻahaʻa	Humility (common).
hala	Pandanus or screw pine (*Pandanus odoratissimus*).
haku	Ambassador(s) (common).
hālau	Meeting house.
hau	Lowland tree (*Hibiscus tiliaceus*), found in many warm countries, some spreading horizontally over the ground forming impenetrable thickets, and some trained on trellises.

Hawaiian Word	English Translation
heiau	Pre-Christian place of worship, shrine; some heiau were elaborately constructed stone platforms, others simple earth terraces. Many are preserved today.
hīhīmanu	Various stingrays (Dasyatidae) and eagle rays (*Actobatus narinari*).
ʻili	Land section, next in importance to an ahupuaʻa and usually a subdivision of an ahupuaʻa.
imu	Underground oven.
iwi kūpuna	Ancestral bone remains (common).
kākou	Collective.
kahu	Honored attendant, guardian, nurse, keeper of ʻunihipili [spirit of a dead person] bones, regent, keeper, administrator, warden, caretaker, master, mistress.
kahuna	Priest, sorcerer, magician, wizard, minister, expert in any profession. Kāhuna—plural of kahuna.
kai	Ocean.
kākou	Collective. We (inclusive, three or more).
kalo	Taro (*Colocasia esculenta*), a kind of aroid cultivated since ancient times for food, spreading widely from the tropics of the Old World. In Hawaiʻi, taro has been the staple from earliest times to the present, and here its culture developed greatly, including more than 300 forms.
kamaʻāina	Native-born, one born in a place, host; native plant; acquainted, familiar, and child.
kānāwai	Equal sharing of water (common).
kapu	Taboo.
kiaʻi	Guardian, watchman, caretaker.
koʻa	Fishing shrine (common).
koko	Blood.
konohiki	Overseer, headman of an ahupuaʻa land division under the chief; land or fishing rights under control of the konohiki.
kuapā	Wall of a fish pond.
kuāuna	Taro patch walls (common). Bank or border of a taro patch; stream bank.
kula	Plain, field, open country, pasture. An act of 1884 distinguished dry or kula land from wet or taro land.
kuleana	Native Hawaiian land rights (common). Right, privilege, concern, responsibility, title, business, property, estate, portion, jurisdiction, authority, liability, interest, claim, ownership, tenure, affair, province.
kupuna, kūpuna	Elders (common). Grandparent, ancestor, relative or close friend of the grandparent's generation, grandaunt, granduncle. Kūpuna—plural of kupuna.
lūʻau	Hawaiian feast.
lei niho palaoa	Ivory pendant, originally probably whale's tooth, rarely of stone or wood, later also of walrus tusk; necklace of beads of whale's teeth. Lit. ivory lei.
leina	Place to leap from.
leina ʻuhane	Leap of the soul; a place where the souls of the dead leaped into the nether world.
limu	Seaweed, algae (common)
loʻi	Irrigated terrace, especially for taro, but also for rice; paddy.
loʻi kalo	Irrigated taro patch.
loko iʻa	Fishpond (common).
lomi	Knead, massage, rub out.
lūʻau	Hawaiian feast.
luna	Supervisor.
luna wai	Water master.

Hawaiian Word	English Translation
mahalo	Gratitude. Respects.
mahele	Land division.
maiʻa	All kinds of bananas and plantains.
mākāhā	Sluice gate, as of a fish pond.
makai	Toward the sea.
makani	Wind.
māla	Garden, cultivated field.
mālama	To take care of, care for, preserve, custodian, caretaker.
malihini	Foreigner, newcomer.
manaʻo	Thought, opinion.
mauka	Toward the mountain.
moku	District, island, islet, section.
mōʻī	King, sovereign, monarch, majesty, ruler, queen.
momona	Abundant.
moʻo	Lizard, water spirit; narrow strip of land.
moʻolelo	Story, tale, myth, history, tradition, literature, legend, journal, log, yarn, fable, essay, chronicle, record, article; minutes, as of a meeting. (From moʻo ʻōlelo, succession of talk; all stories were oral, not written).
niho	Wall foundation (common). Stones set interlocking, as in a wall.
noʻonoʻo	Thoughtful.
ʻōlelo noʻeau	Proverb, wise saying, traditional saying.
oli	Chant that was not danced to, especially with prolonged phrases chanted in one breath, often with a trill at the end of each phrase; to chant thus.
olonā	A native shrub (*Touchardia latifolia*).
ʻōpala	Trash.
pali	Cliff, precipice, steep hill or slope.
pihi	Fish.
pōhaku pele	Volcanic rock (common).
poi	The Hawaiian staff of life, made from cooked taro corms, or rarely breadfruit, pounded and thinned with water.
pono	Propriety (common). Moral, fitting, proper, righteous, right, upright, just, virtuous, fair, beneficial, successful, in perfect order, accurate, correct, eased, relieved.
puʻu	Any kind of protuberance from a pimple to a hill: hill, peak, cone, hump, mound, bulge, heap, pile, portion, bulk, mass, quantity, clot, bunch, knob.
puaʻa	Pig.
puhi	Eel.
pule	Prayer.
ʻuala	Sweet potato (*Ipomoea batatas*).
uhi	Yam (*Dioscorea alata*).
wahi pana	Storied place (common). Legendary place.
wai	Fresh water (common).
waiwai	Wealth, abundance, prosperity.
wao akua	The realm of gods (common). A distant mountain region, believed inhabited only by spirits (akua).
wao kanaka	The real of man (common). An inland region where people may live or occasionally frequent.
wauke	Paper mulberry (*Broussonetia papyrifera*).

Common and Scientific Names for Plants and Animals Mentioned by Community Participants

Common Names		Possible Scientific Names		Source
Hawaiian	Other	Genus	Species	
ʻaʻama	crab	*Grapsus*	*grapsus*	Pukui and Elbert 1986
āholehole	juvenile āhole (Hawaiian flagtail)	*Kuhlia*	*xenura*	Hoover 1993
ʻamaʻama	striped mullet	*Mugil*	*cephalus*	Hoover 1993
awa	milkfish	*Chanos*	*chanos*	Hoover 1993
haole (kūhonu)	white crab	*Portunus*	*sanguinolentus*	Pukui and Elbert 1986
hau	beach hibiscus	*Hibiscus*	*tiliaceus*	Wagner et al. 1999
kalo	taro	*Colocasia*	*esculenta*	Wagner et al. 1999
kūhonu	crab	*Portunus*	*sanguinolentus*	Pukui and Elbert 1986
limu ʻeleʻele	seaweed, algae	*Entermorpha*	*prolifera*	Abbott and Williamson 1974
limu huluhuluwaena	seaweed, algae	*Grateloupia*	*filicina*	Abbott and Williamson 1974
limu kohu	seaweed, algae	*Asparagopsis*	*taxiformis*	Abbott and Williamson 1974
limu manauea	seaweed, algae, ogo	*Gracilaria*	*coronopifolia*	Abbott and Williamson 1974
māmaki	an endemic nettle	*Pipturus*	spp.*	Wagner et al. 1999
manini	convict tang	*Acanthurus*	*triostegus*	Hoover 1993
ʻōʻio	bonefish	*Albula*	spp.*	Hoover 1993
ʻōlena	turmeric	*Curcuma*	*domestica*	Pukui and Elbert 1986
ʻōpae lōlō	brackish-water shrimp or prawn	*Penaeus*	*marginatus*	Pukui and Elbert 1986
weke	goatfish	*Mulloidichthys*	spp.*	Hoover 1993

* spp. = multiple species

Section 1. Introduction

1.1 Introduction to the National Estuarine Research Reserve System

The National Estuarine Research Reserve System (NERRS) was created by the Coastal Zone Management Act (CZMA) of 1972, as amended, to augment the National Coastal Zone Management Program, which is dedicated to comprehensive, sustainable management of the nation's coasts.

The Reserve System is a network of protected areas representative of the various biogeographic regions and estuarine types in the United States. Reserves are established for long-term research, education, and interpretation to promote informed management of the nation's estuaries and coastal habitats. (Title 15, Code of Federal Regulations (CFR), Part 921.1(a)) (Appendix A). The Reserve System currently consists of 28 reserves in 23 states and territories, protecting over 1 million acres of estuarine lands and waters (Figure 1-1).

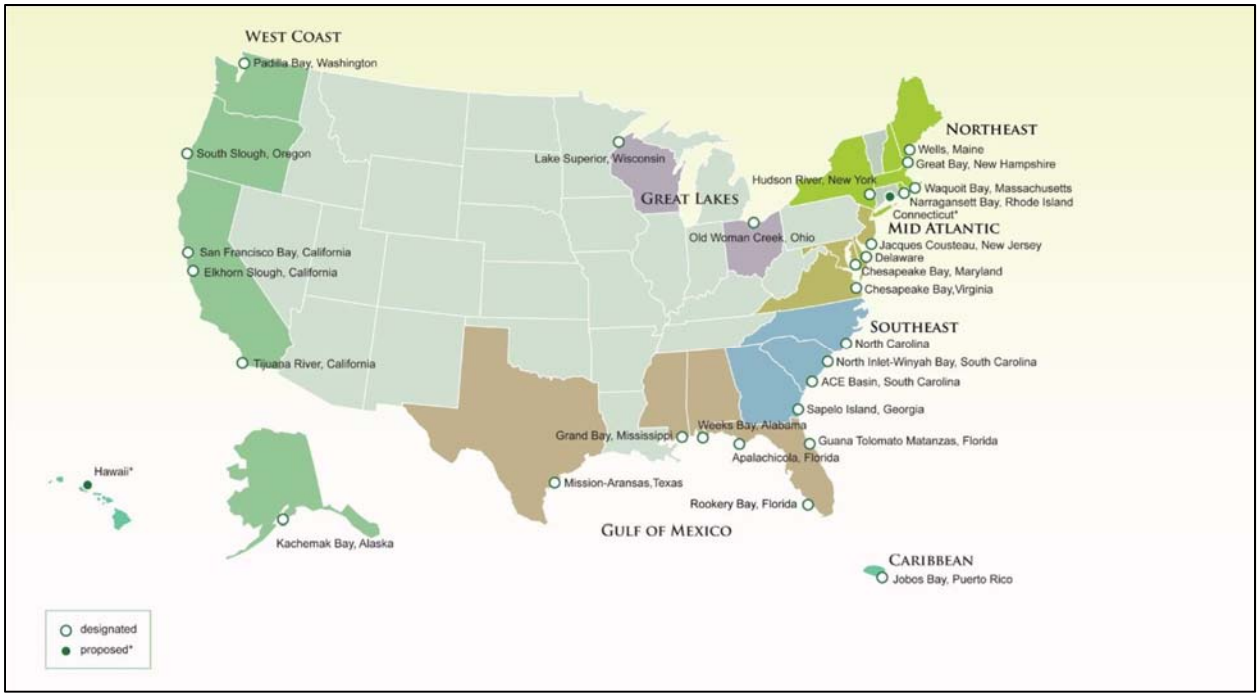

Figure 1.1. National Estuarine Research Reserve System

The Reserve System is a partnership program between the National Oceanic and Atmospheric Administration (NOAA) and the coastal states. NOAA provides funding, national guidance, and technical assistance. The state partner manages reserve resources on a daily basis, working collaboratively with local and regional partners.

1.1.1 National Estuarine Research Reserve System Strategic Goals

Estuaries are biologically rich, economically valuable, and highly vulnerable ecosystems. The vision and mission of the reserve system reflect the importance of these systems within our communities.

- **Vision**: Resilient estuaries and coastal watersheds where human and natural communities thrive.
- **Mission**: To practice and promote stewardship of coasts and estuaries through innovative research, education, and training using a place-based system of protected areas.

The program goals, per federal regulations (15 CFR 921.1(b)), outline five specific goals for the reserve system:

1. Ensure a stable environment for research through long-term protection of National Estuarine Research Reserve System resources;
2. Address coastal management issues identified as significant through coordinated estuarine research within the system;
3. Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation;
4. Promote federal, state, public, and private use of one or more reserves within the system when such entities conduct estuarine research; and
5. Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.

These foundational goals are complemented by those that are systematically set by the program every 5 years. Strategic planning has been an integral part of the NERRS for nearly twenty years. The planning process is designed to bridge national program direction with local coastal management needs through a representative and participatory process that supports NOAA's mission of science, service, and stewardship. The *2011–2016 Reserve System Strategic Plan* focuses reserve core strengths of research, education, and training on three core issues: climate change, habitat protection, and water quality. The Reserve System Strategic Plan goals are:

1. **Protected Places**: Estuaries and coastal watersheds are better protected and managed by implementing place-based approaches at reserves.
2. **Science**: NERRS scientific investigations improve understanding and inform decisions affecting estuaries and coastal watersheds.
3. **People**: NERRS education and training increases participants' environmental literacy and ability to make science-based decisions related to estuaries and coastal watersheds.

1.1.2 Biogeographic Regions and Boundaries of the National Estuarine Research Reserve System

NOAA has identified 11 distinct biogeographic regions and 29 subregions in the United States, each of which contains several types of estuarine ecosystems (15 CFR 921, Appendix 1). When complete, the reserve system will contain examples of estuarine hydrologic and biological type characteristic of each biogeographic region. As of 2016, the reserve system included 28 reserves with two states in the process of designating a reserve.

Reserve boundary size will vary greatly depending on the nature of the ecosystem. Boundaries must include an adequate portion of the key land and water areas of the natural system to approximate an ecological unit and to ensure effective conservation. Reserve boundaries encompass areas for which adequate state control has or will be established by the managing entity over human activities occurring within the reserve. Reserve boundaries include a "core" area which comprises key land and water encompassing resources representative of the total ecosystem, which if compromised could endanger the research objectives of the reserve, as well as a "buffer" area designed to protect the core area and provide additional protection for estuarine-dependent species, including those that are rare or endangered. Buffer areas may also include areas necessary for facilities required for research and interpretation. Additionally, buffer areas are identified to accommodate a shift of the core area as a result of biological, ecological, or geomorphological change which reasonably could be expected to occur. (15 CFR 921.11 (c)(3)).

1.1.3 National Estuarine Research Reserve Administrative Framework

The process for federal designation of a NERR has many steps and involves many individuals and organizations. While each reserve is a partnership program between NOAA and a coastal state, there are many entities that collaborate to support designation of a reserve. Other partners include federal and state agencies, nonprofit groups, universities, and members of the local community. For more information on the designation process see http://nerrs.noaa.gov/about/designation-process.html.

Upon designation, the reserve implements the approved reserve management plan and NOAA may provide funding, based on appropriations. A reserve may apply to NOAA for funds to help support implementation of the management plan by funding operations, research, monitoring, education/interpretation, training, stewardship, development projects, facility construction, and land acquisition. Management plans provide a vision and framework to guide reserve activities during a 5-year period and enable the reserves and NOAA to track progress and realize opportunities for growth. Each management plan contains the reserve goals, objectives, and strategies, supported by programs focused on research and monitoring, education and outreach, training, and stewardship. The plan also outlines administration, public access, land acquisition, and facility plans and needs, as well as restoration and resource manipulation plans, if applicable. Reserves are increasingly confronted with complex questions regarding new uses in or near reserves that may or may not be compatible with the reserve system's mission. A thoughtful and comprehensive management plan

provides a foundation for addressing these challenges to protect and manage reserve resources wisely and ensure that the public and coastal decision makers value and protect coastal resources.

NOAA administers the Reserve System and establishes standards for designating and operating reserves, provides support for reserve operations and system-wide programming, undertakes projects that benefit the reserve system, and integrates information from individual reserves and programs to support decision-making at the national level. Additionally, NOAA periodically evaluates reserves for compliance with federal requirements and with the individual reserve's federally approved management plan, as mandated under Section 312 of CZMA (15 CFR 921.40).

NOAA currently provides leadership and support for three system-wide programs: the System-Wide Monitoring Program, the K-12 Estuarine Education Program, and the Teachers on the Estuary (TOTE), as well as the NERRS Science Collaborative. It also provides support for initiatives focused on the reserve system's priorities: climate change, water quality, and habitat protection.

1.2 He'eia National Estuarine Research Reserve (NERR)

1.2.1 History of Reserve Designation in Hawai'i

The insular biogeographic region in the United States is not yet represented in the NERRS. This region comprises three subregions: the Hawaiian Islands, the Western Pacific Islands, and the Eastern Pacific Islands. With the designation of a NERR in Hawai'i, the system will have a tenth region (of 11 total regions) and a twenty-first subregion (of 29 total subregions) represented.

In 1978, a NERR was designated in Hawai'i, in the Waimanu Valley on the windward coast of the Island of Hawai'i. The NERR was administered by the Department of Land and Natural Resources (DLNR), Division of Forestry and Wildlife (DOFAW). Waimanu is a remote drowned river valley, accessible only by boat, helicopter, or a strenuous hike on a 9-mile switchback trail. This inaccessibility was one of the reasons the Governor of Hawai'i requested withdrawal of designation of this site in 1993 (PBR Hawai'i 2014). However, interests about establishing a NERR in Hawai'i continued, especially for He'eia.

Governor Neil Abercrombie submitted a letter of interest in July 2012 to propose an expansion of the NERRS to include the unrepresented insular paleotropical region. He designated the Office of Planning (OP) as the lead agency for the site selection process. The Coastal Zone Management (CZM) Program, under the OP, restarted the NERR site selection process for Hawai'i in February 2013. In his letter, the Governor identified the University of Hawai'i as a potential partner.

Phase I of the site selection process involved developing site selection criteria, forming a Site Selection Committee (SSC) to approve the criteria, forming a Site Evaluation Committee (SEC) to perform a technical review of proposed NERR sites, and soliciting proposals from the public (Figure 1-2). OP received

inquiries from all four counties but proposals were received from only two sites: He‘eia in Kāne‘ohe Bay on O‘ahu and Hilo Bay on Hawai‘i Island (PBR Hawai‘i 2014).

In Phase II, the SSC reviewed these two site proposals and was given all available information to consider. The committee selected He‘eia as the preferred site. The site nomination document, including comments received from the public, was forwarded to the Governor in the first quarter of 2014. This document highlighted the fact that in spite of being highly altered by human influence, the He‘eia site is representative of the state and region, and research conducted here is expected to have applications useful for other sites across the state. This site is also easily accessible for researchers, education groups, and the public. Current activities in He‘eia are compatible with existing management plans such as the *Hawai‘i Ocean Resources Management Plan* (OP 2013) and the *Kāne‘ohe Bay Master Plan* (OP 1992), and were considered in the development of this He‘eia NERR management plan. The site also offers excellent opportunities for expanded educational and interpretive activities with easy access for students, local residents, and tourists.

This management plan was developed consistent with NOAA’s Environmental Impact Statement (EIS) development during Phase III of the site designation process.

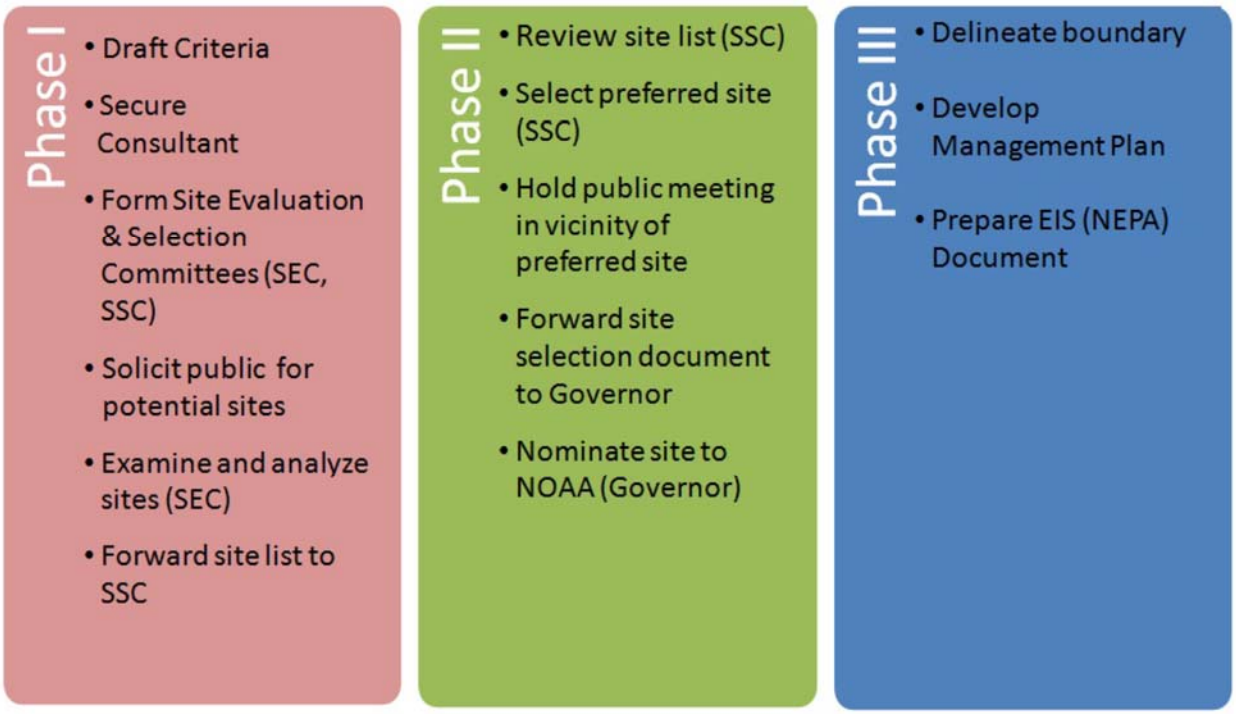

Figure 1.2. NERR Site Selection Process in Hawai‘i

1.2.2 He‘eia NERR Site Description

The He‘eia estuary is located in Kāne‘ohe Bay within the Ko‘olaupoko region on the northeastern or windward shore of the island of O‘ahu (Figure 1-3). Kāne‘ohe Bay is the largest sheltered body of water in the Hawaiian Islands, with a total surface area of 18 square miles (11,000 acres). The bay is about 8 miles

long; oriented northwest to southeast, 2.6 miles wide, and protected by an outer barrier reef. The bay receives relatively large freshwater inputs from numerous streams originating from the eastern-facing and windward slopes of the central Koʻolau Mountain Range. The barrier reef has a major influence on the circulation of waters in the bay, creating diverse aquatic habitats. Compared to an open coastline, the semi-enclosed nature of the bay makes it more vulnerable to damage by factors associated with urbanization and agricultural development (Jokiel 1991). The Heʻeia estuary is in the southern portion of Kāneʻohe Bay. The estuary is influenced by runoff from the surrounding watershed as well as by the exchange of seawater from the ocean.

The Heʻeia NERR includes the estuary, wetlands, marine waters, and upland areas. The total acreage of the Heʻeia NERR is approximately 1,385 acres. It encompasses Heʻeia State Park to the north, Heʻeia Fishpond in the center, wetlands to the west and south, the University of Hawaii's (UH) Hawaiʻi Institute of Marine Biology (HIMB) property on Moku o Loʻe (Coconut Island) to the east, and a large expanse of marine waters with patch and fringing reefs.

1.2.3 Land Ownership in the Heʻeia NERR

The Heʻeia NERR comprises a mix of public and private lands (Figure 1-4). The public lands in the Heʻeia NERR are owned by three State of Hawaiʻi agencies: DLNR, which owns Heʻeia State Park, coastal parts of Moku o Loʻe, and the marine waters including the Marine Laboratory Refuge wildlife sanctuary that immediately surrounds Moku o Loʻe; University of Hawaiʻi Foundation owns the central part of Moku o Loʻe; and the Hawaiʻi Community Development Authority (HCDA), which owns the wetland and upland areas identified as the Heʻeia Community Development District leased by Kākoʻo ʻŌiwi (see Section 2).

The Heʻeia NERR also includes the Heʻeia Fishpond, a private property owned by Kamehameha Schools. Two kuleana parcels (privately owned Hawaiian homestead lots) that are located within the site boundaries are not included in the Heʻeia NERR. Likewise, the Heʻeia NERR boundary was drawn to avoid overlap with private land parcels located in the residential areas adjacent to the site. Table 1-1 lists the properties included in Heʻeia NERR, the landowners and managing entities, and property sizes. Activities related to roads and infrastructure within the Kamehameha Highway right of way located within the NERR external boundary are excluded from the NERR management operations described in this management plan.

The mix of public and private land ownership create both opportunities and challenges for the Heʻeia NERR. Since the State does not have ownership or management control over the private land of the Heʻeia Fishpond, it is only through the cooperation of the private land owners that the boundaries of the Heʻeia NERR includes the critical portion of the Heʻeia estuary that flows into Kāneʻohe Bay through the fishpond. Challenges created by the private land ownership include limited public access.

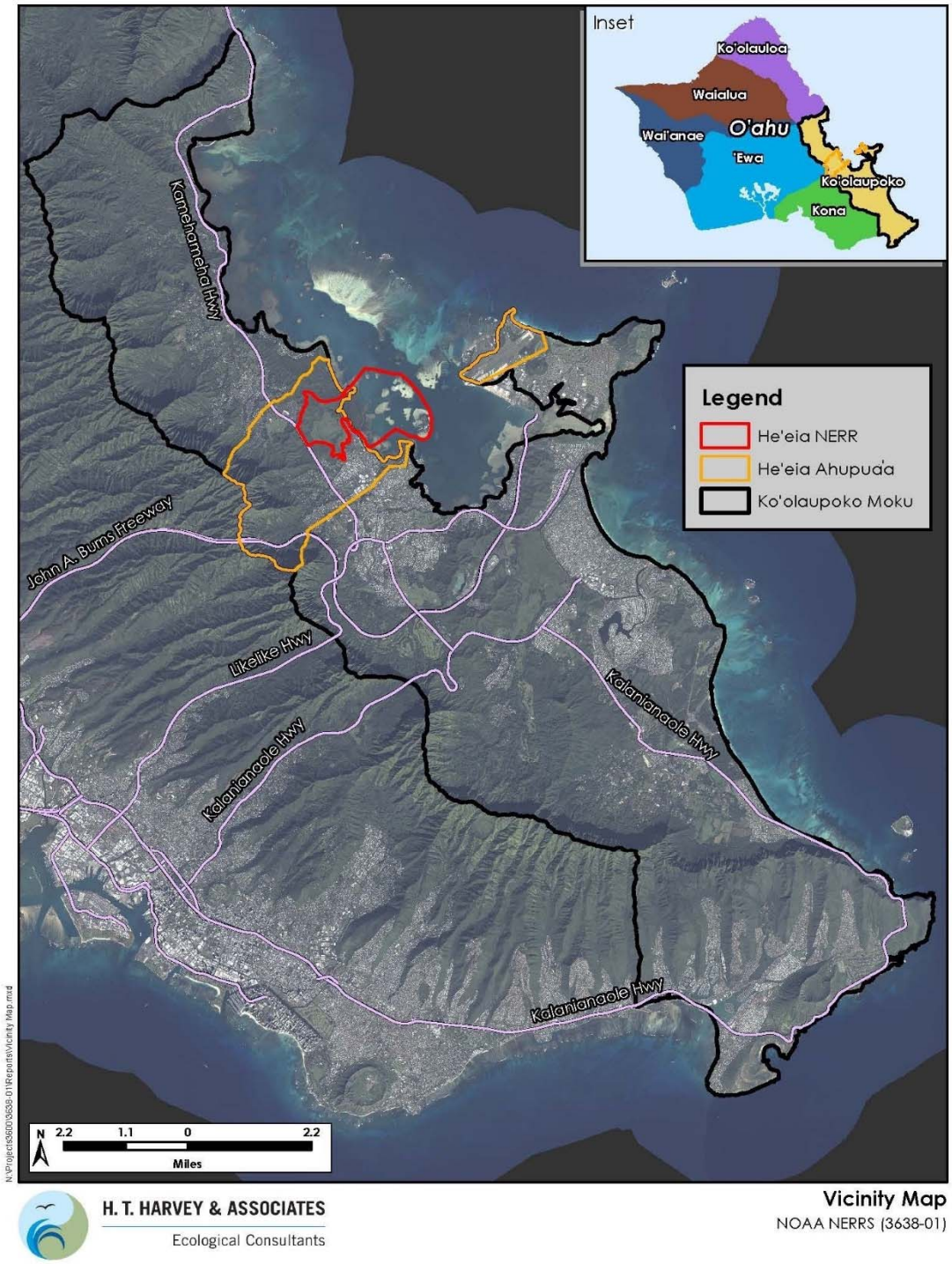

Figure 1.3. Location of He‘eia NERR in Kāne‘ohe Bay in the Ko‘olaupoko Region of O‘ahu

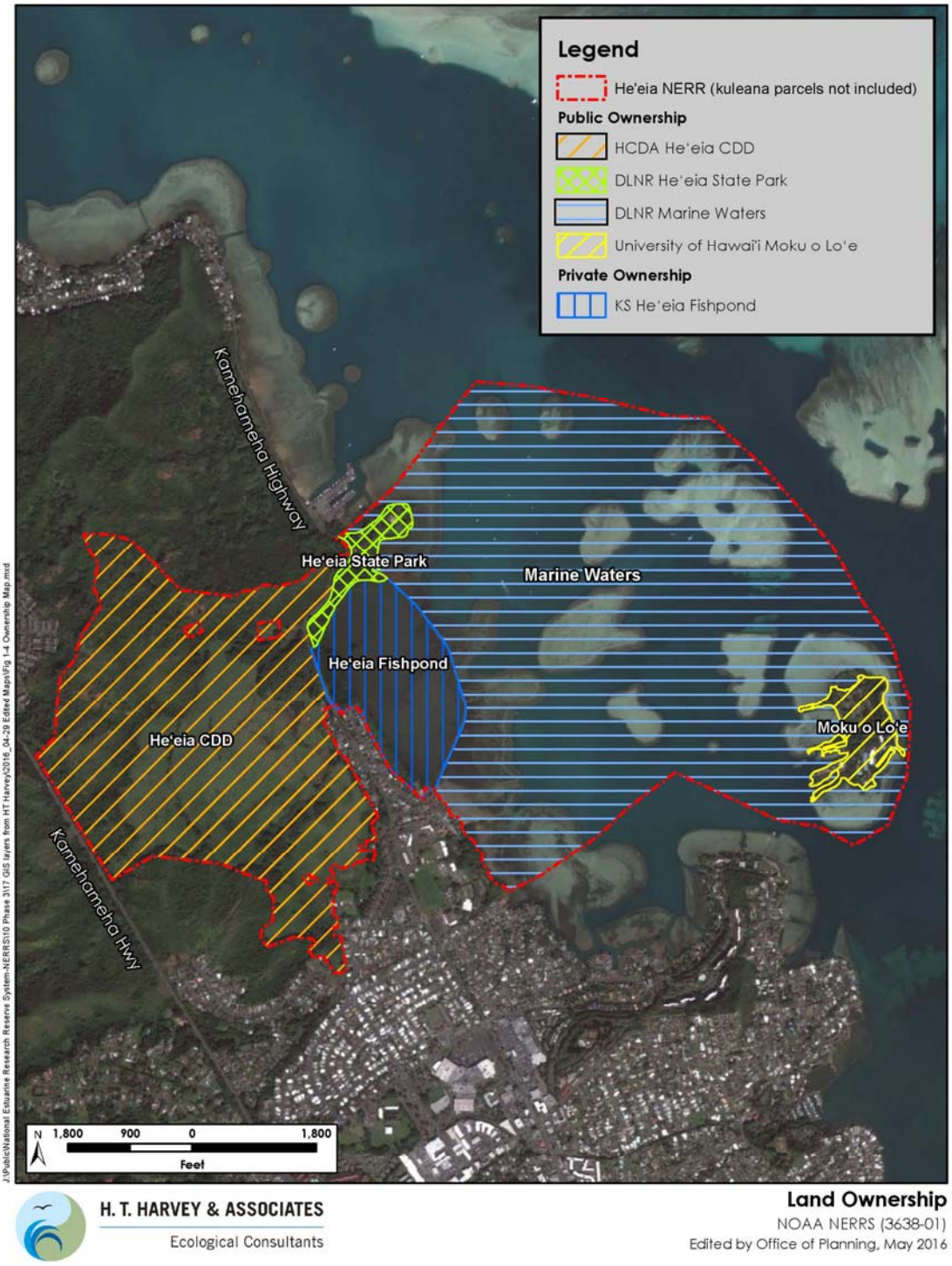

Figure 1.4. Land Ownership in He‘eia NERR

Table 1-1. Landownership, Managing Entity, and Acreage of Properties within the He‘eia NERR

Property Name or Land Type	Landowner	Managing Entity	Approximate Area (acres)
Public lands			
He‘eia State Park	DLNR	State Parks Division/ Kama‘āina Kids (lessee)	19
Marine waters	DLNR	Division of Aquatic Resources/Land Division	822
Moku o Lo‘e	University of Hawai‘I Foundation	HIMB	28
He‘eia CDD	HCDA	Kāko‘o ‘Ōiwi (lessee)	419 (not including health center parcel)
Private lands			
He‘eia Fishpond	Kamehameha Schools	Paepae o He‘eia (lessee)	97
Total acres			**1385**

Notes: DLNR = Department of Land and Natural Resources; HCDA = Hawai‘i Community Development Authority; HIMB = Hawai‘i Institute of Marine Biology.

1.2.4 He‘eia NERR Boundary Description

1.2.4.1 Boundary Criteria

NOAA’s criteria for determining the boundaries of a NERR are outlined in the Code of Federal Regulations (15 CFR 921.11). These criteria are summarized below:

- **Key land and water areas that approximate an ecological unit:** Reserve boundaries must encompass an adequate portion of key land and water areas of the natural system to approximate an ecological unit and should encompass resources representative of the total biogeographic habitat.
- **Encompass areas with adequate controls:** NOAA regulations require that there be a level of control over uses and activities to ensure that the ecological integrity of the reserve is maintained for sustained research and education. Specifically, the regulations state that reserve boundaries must encompass the area within which adequate control has or will be established by the managing entity over human activities occurring within the reserve.
- **Management considerations:** The administrative burden and responsibility for operating a reserve and associated research, stewardship, and educational programs should be a significant consideration in the site selection process and in the delineation of the reserve boundaries. Given the limited funds available to support reserve programs, it is also important to develop a reasonable boundary that will establish a credible reserve without creating an overwhelming administrative burden.

- **Research, Monitoring, education, and stewardship needs and goals:** The research, monitoring, education, and, particularly in the case of the He‘eia NERR, the cultural and land stewardship needs and goals of the reserve, are important considerations in developing a boundary. These needs and goals define the purpose of establishing a reserve and should play a primary role in defining boundaries and guiding future land acquisition needs.

1.2.4.2 Core and Buffer Area Rationale

Federal regulations (15 CFR 921.11) state that reserve boundaries generally encompass two areas: core and buffer areas. The regulations define key or “core” land and water areas as containing ecological units of a natural estuarine system which preserves, for research purposes, a full range of significant physical, chemical, and biological factors contributing to the diversity of fauna, flora, and natural processes occurring within the estuary (See Section 1.2.4.3 for a description of the core area in the He‘eia NERR).

> [The core area is] so vital to the functioning of the estuarine ecosystem that it must be under a level of control sufficient to ensure the long-term viability of the reserve for research on natural processes...[These areas] should encompass resources that are representative of the total ecosystem which, if compromised, could endanger the research objectives of the reserve.

The He‘eia NERR core areas were selected based on the following criteria:

1. They are vital to the function of the He‘eia estuary.
2. State can maintain a sufficient level of control over the areas to ensure the long-term viability of the He‘eia estuary for research and natural processes.
3. The areas encompass resources representative of the He‘eia estuary system.
4. The preservation of the core areas will contribute to the preservation of a full range of significant physical, chemical, and biological factors essential to the diversity of fauna, flora, and natural processes occurring within the He‘eia estuary, as determined through:
   - the *Recovery Plan for Hawaiian Waterbirds* (U.S. Fish and Wildlife Service [USFWS] 2011),
   - the *Kāne‘ohe Bay Master Plan* (OP 1992), and
   - the *Atlas of Hawaiian Watersheds and Their Aquatic Resources, Bishop Museum and Division of Aquatic Resources* (Parham et al. 2008).

The federal regulations (15 CFR 921.11) define a buffer area as an “area adjacent to or surrounding key lands and water areas and essential to their integrity. Buffer zones protect the core area and provide additional protection for estuarine-dependent species.” The buffer area may include areas for research and education facilities (See Section 1.2.4.4 for a description of the buffer area in the He‘eia NERR).

The He‘eia NERR buffer areas were selected based on the following criteria:

- The areas are able to protect the core area and provide additional protection for species that rely on the core area.

- The areas are located adjacent to or surrounding, or are essential to the integrity of, the core area.
- The buffer areas provide an opportunity to accommodate future shifts in the core area as a result of successful restoration or climate impacts.
- Managers can maintain a level of control over the areas sufficient to support the long-term viability of the He‘eia NERR for the recovery of natural processes, as well as for research and education.

1.2.4.3 He‘eia NERR Core Areas

The core area in the He‘eia NERR encompasses about 624 acres of aquatic habitats that are currently managed by the State and are suitable sites for conducting research and monitoring activities (Figure 1-5). The core area is comprised of coral reefs and waters of Kāne‘ohe Bay, including the reef immediately surrounding Moku o Lo‘e. The coral reefs and open water in the He‘eia NERR are representative of the coral reef ecosystem in Kāne‘ohe Bay as well as of the Hawaiian Islands archipelago. A network of estuaries, fed by multiple streams, is part of the larger bay, and the core area is likewise affected by the influx of fresh water and by changes in the estuarine environment.

Sixty-four acres of coral reefs immediately surrounding Moku o Lo‘e comprise the Hawai‘i Marine Laboratory Refuge. This refuge is highly protected by limitations on public access and a prohibition on the removal of marine organisms, except for research purposes. This high level of protection makes the refuge well suited to being included in the He‘eia NERR core area.

1.2.4.4 He‘eia NERR Buffer Areas

The buffer areas of the He‘eia NERR are contiguous with the core area and encompass about 762 terrestrial and aquatic acres (Figure 1-5). These areas were found suitable to be designated as buffers because they are vital to the long-term viability of the natural process and research and educational activities, and these areas are also currently used for, or planned to be used for, major agricultural, aquacultural, restoration-related, recreational, or commercial activities. The 476 acres of land in the He‘eia NERR buffer area consist of HCDA’s He‘eia CDD, the He‘eia Fishpond, He‘eia State Park, and Moku o Lo‘e. The 286 acres of aquatic areas in the He‘eia NERR’s buffer consist of the He‘eia Fishpond; Patch Reefs #7, 8, 9, and 10; about 111 acres of water immediately surrounding Patch Reef #7, and about 32 acres of water to the south of Patch Reef #10.

The He‘eia Fishpond and the He‘eia CDD were designated as buffer areas because of ongoing and planned aquacultural and agricultural activities, ongoing restoration of the fishpond, and planned removal of mangroves and restoration of this area to natural estuarine habitat. Because these areas provide access and boat mooring facilities, they are suitable for inclusion in the buffer area. The Division of Aquatic Resources (DAR) is proposing to establish a coral reef mitigation bank on Patch Reef #10 and use Patch Reef #9 as a reference site, therefore making these areas suitable for inclusion in the buffer area. DLNR’s Division of

Boating and Ocean Recreation (DOBOR) has designated and manages about 111 acres of water around Patch Reef #7 including a portion of Patch Reef #8 as Ocean Recreation Management Area (ORMA) restricted zones. A portion of these areas are used for water recreation (jet skiing, water skiing, and water sledding). Similarly, about 32 acres of water south of Patch Reef #10 are designated by DOBOR for the mooring of recreational and commercial boats. As such, these waters see relatively high levels of boat traffic and provide access to core marine areas, and were considered suitable for inclusion in the buffer area.

The permitted uses in the core and buffer areas, and existing state and federal laws and regulations that govern these permitted uses, are described in Section 6, in the resource protection plan. The designation of the He‘eia NERR will not change any existing uses; nevertheless, the reserve managers will maintain awareness of land and water uses and ensure that the He‘eia NERR goals and objectives are pursued in harmony with existing uses.

1.3 Ecological Attributes of the He‘eia NERR

1.3.1 Habitats

The habitats in the He‘eia NERR can be broadly categorized as uplands, wetlands, freshwater stream, estuarine and coastal, and marine (Figure 1-6). These are outlined in the following sub-sections.

1.3.1.1 Uplands

The upland areas in the He‘eia NERR are a mosaic of built-up or developed areas and undeveloped or natural areas. The undeveloped or natural upland areas in the He‘eia NERR occur in (1) He‘eia State Park (19 acres) (Figure 1-7), (2) areas between the He‘eia Fishpond and the residential neighborhood (9 acres) (Figure 1-8), (3) emergent lands on Moku o Lo‘e (28 acres), (4) natural upland and fill areas in wetlands in the He‘eia CDD (approximately 15 to 20 acres west of Kamehameha Highway), and (5) 200 acres of forested land at the foothills of the Ko‘olau Mountains on the HCDA property.

The vegetation in the upland areas is dominated by invasive plant species such as Java plum (*Syzygium cumini*), strawberry guava (*Psidium guajava*), ironwood (*Casuarina equisetifolia*), octopus tree (*Schefflera actinophylla*), and koa haole (*Leucaena leucocephala*) (Krauss 1976, Lamoureux 1983, Calvin and Kim 1990, PBR Hawai‘i 1993, Townscape 2011a). Few native plant species such as pili (*Heteropogon contortus*), ‘ākia (*Wikstroemia* sp.), mountain naupaka (*Scaevola gaudichaudii*), and ‘ōhi‘a lehua (*Metrosideros collina*) occur within the forested upland areas of the He‘eia NERR on HCDA lands (Krauss 1976). The native loulu palm (*Pritchardia sp.*), naupaka (*Scaevola sericea*), and indigenous hala (*Pandanus tectorius*) and hau (*Hibiscus tiliaceus*) trees also grow in He‘eia State Park and in the residential neighborhood adjacent to the He‘eia NERR (Lamoureux 1983, Weissich 1993). No rare, threatened, or endangered plants are known to occur in the He‘eia NERR except for a single plant of the endangered Achyranthus (*Achyranthes splendens* var. *rotunda*) which was found to be cultivated in the residential

neighborhood near the fishpond. The He‘eia NERR also does not overlap with critical habitat for any threatened or endangered plant species (USFWS 2015a). Restoration of upland habitats in the future has potential to control and remove invasive species and replace these with native plants.

The fauna found in the He‘eia NERR include the common coastal, rural, and urban-introduced birds and mammals typically found in beachsides, gardens, parklands, and agricultural areas on O‘ahu, such as feral cats (*Felis catus*), rats (*Rattus* sp.), common mynas (*Acridotheres tristis*), zebra doves (*Geopelia striata*), northern cardinals (*Cardinalis cardinalis*), common waxbills (*Estrilda astrild*), cane spiders (*Heteropoda* sp.), and the introduced monarch butterfly (*Danaus plexippus*) and honeybee (*Apis mellifera*) (Calvin Kim and Associates 1990, Helber Hastert & Fee 2007, Community Planning and Engineering, Inc. 2014). No threatened or endangered forest birds have been reported to occur in the reserve; however, based on historical or regional records, the Hawaiian owl (*Asio flammeus sandwichensis*) and O‘ahu creeper (*Paroreomyza maculata*) have the potential to occur in the He‘eia NERR (Townscape 2011a). It is suspected that Hawai‘i’s only terrestrial native mammal, the Hawaiian hoary bat (*Lasiurus cinereus semotus*), may occur in the He‘eia NERR, because it is known to forage over ponds and bays and roost in dense forests similar to the hau and mangrove vegetation in the He‘eia NERR (Helber Hastert & Fee 2007, Community Planning and Engineering, Inc. 2014). As with the plants, none of the upland habitats in the He‘eia NERR are identified as proposed or listed critical habitat for any endangered species (Helber Hastert & Fee 2007, Townscape 2011a, Community Planning and Engineering, Inc. 2014, USFWS 2015a).

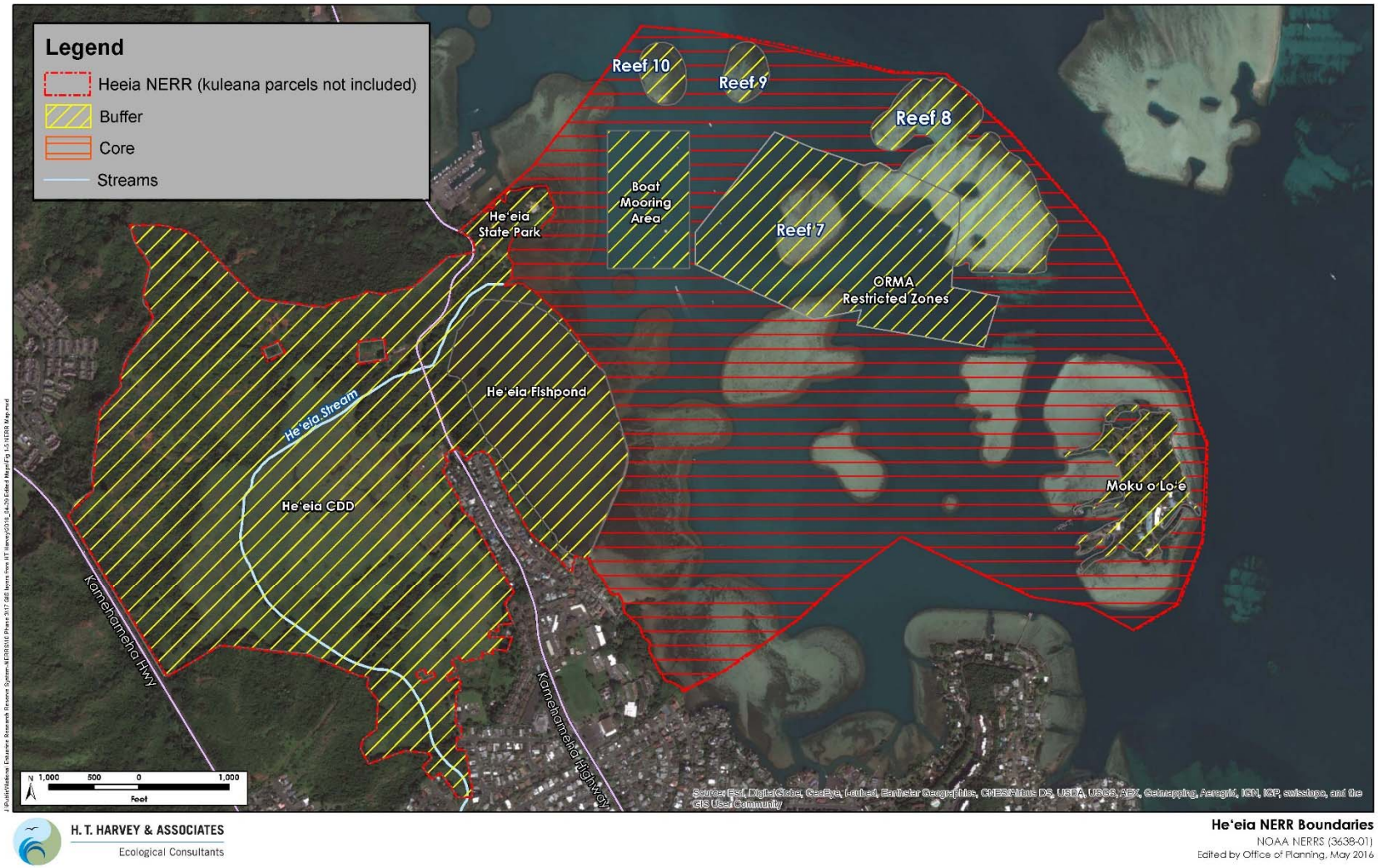

Figure 1.5. Core and buffer areas of the He'eia NERR

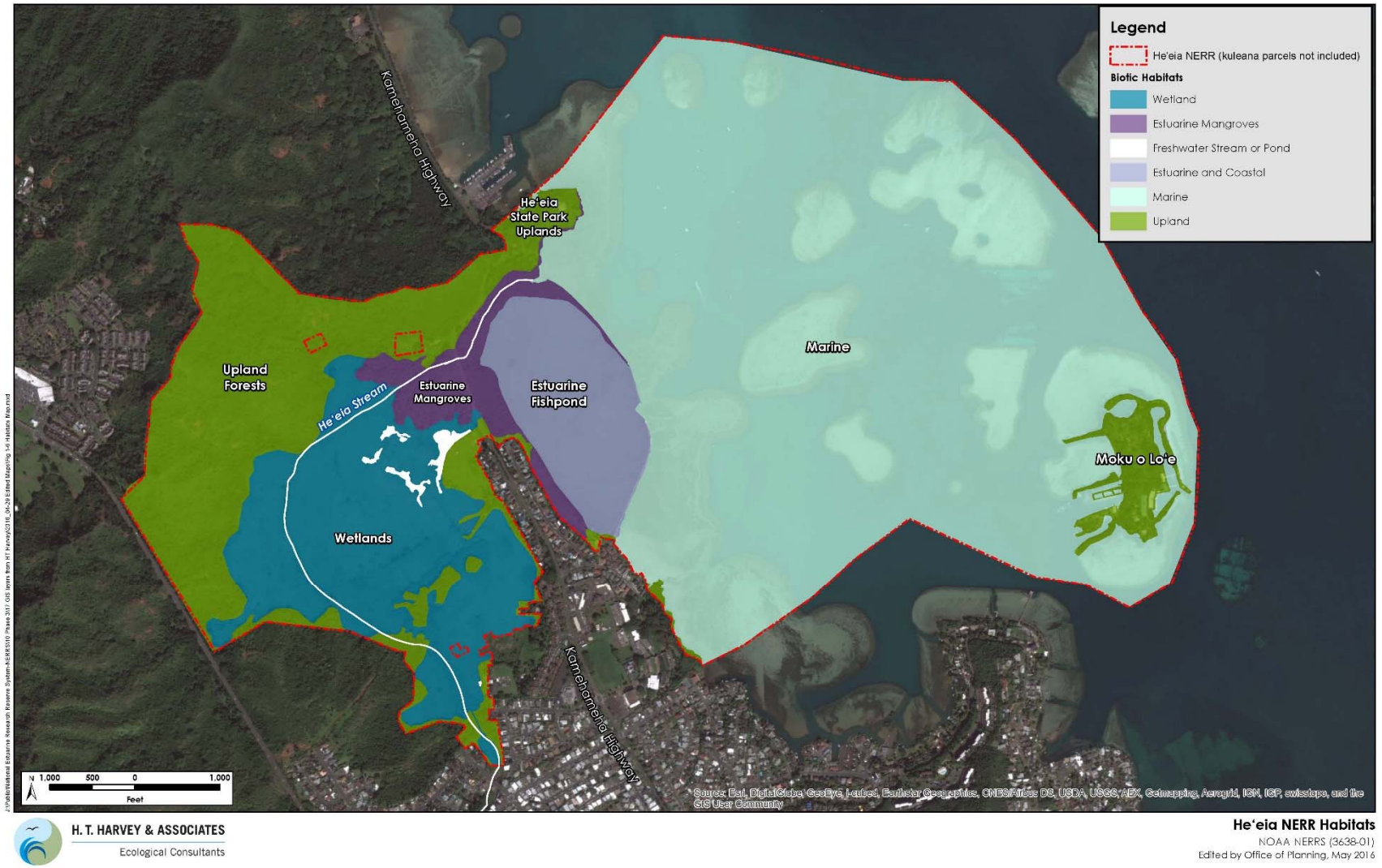

Figure 1.6. He'eia NERR habitat types

Figure 1.7. Landscaped upland area at He‘eia State Park

(Photo courtesy of H. T. Harvey & Associates)

Figure 1.8. Area adjacent to He‘eia Fishpond

(Photo courtesy of H. T. Harvey & Associates)

1.3.1.2 Wetlands

The wetlands in the He‘eia NERR are fed by the waters of Ha‘ikū Stream and Ioleka‘a Stream, which converge upstream of the wetlands to form He‘eia Stream. Five types of wetlands (based on the National

Wetlands Inventory, USFWS 2015b) occur within the He‘eia NERR boundaries: (1) estuarine and marine deepwater, (2) estuarine and marine wetland, (3) freshwater emergent wetland, (4) freshwater forested/shrub wetland, and (5) freshwater pond (Figure 1-9). These different types of wetlands in the He‘eia NERR occur on (1) HCDA lands to the west of Kamehameha Highway; (2) along the banks of the He‘eia Stream in He‘eia State Park; (3) along the northwestern, western, and southwestern walls of the fishpond (USFWS 2015b); and (4) in estuarine and marine deepwater portions of Kāne‘ohe Bay (Figure 1-9). The estuarine and marine deepwater type wetland is discussed below under the marine habitat type (Section 1.3.1.5), and the estuarine and marine wetland is discussed below under the estuarine and coastal habitat type (Section 1.3.1.4).

The freshwater and emergent wetland in the He‘eia NERR largely comprises the He‘eia Stream, marsh, and seasonally wet grasslands. He‘eia Stream, along the southwestern boundary of the He‘eia NERR, is lined with dense hau trees. Throughout its course in the wetlands, He‘eia Stream is choked by California grass (*Urochloa mutica*) and other invasive species that impede its flow and water quality (Townscape 2011a, Hawai‘i Department of Health [HIDOH] 2014). Kāko‘o ‘Ōiwi plans to restore the stream channels with native riparian plants to create habitat for native aquatic fish, shrimp, and other organisms now absent from the stream (see Section 2.3). Enhancing the presence of native plants in these areas through the restoration of the area (Section 11) will provide additional ecosystem services such as native wildlife habitat, shoreline stabilization and soil and nutrient retention.

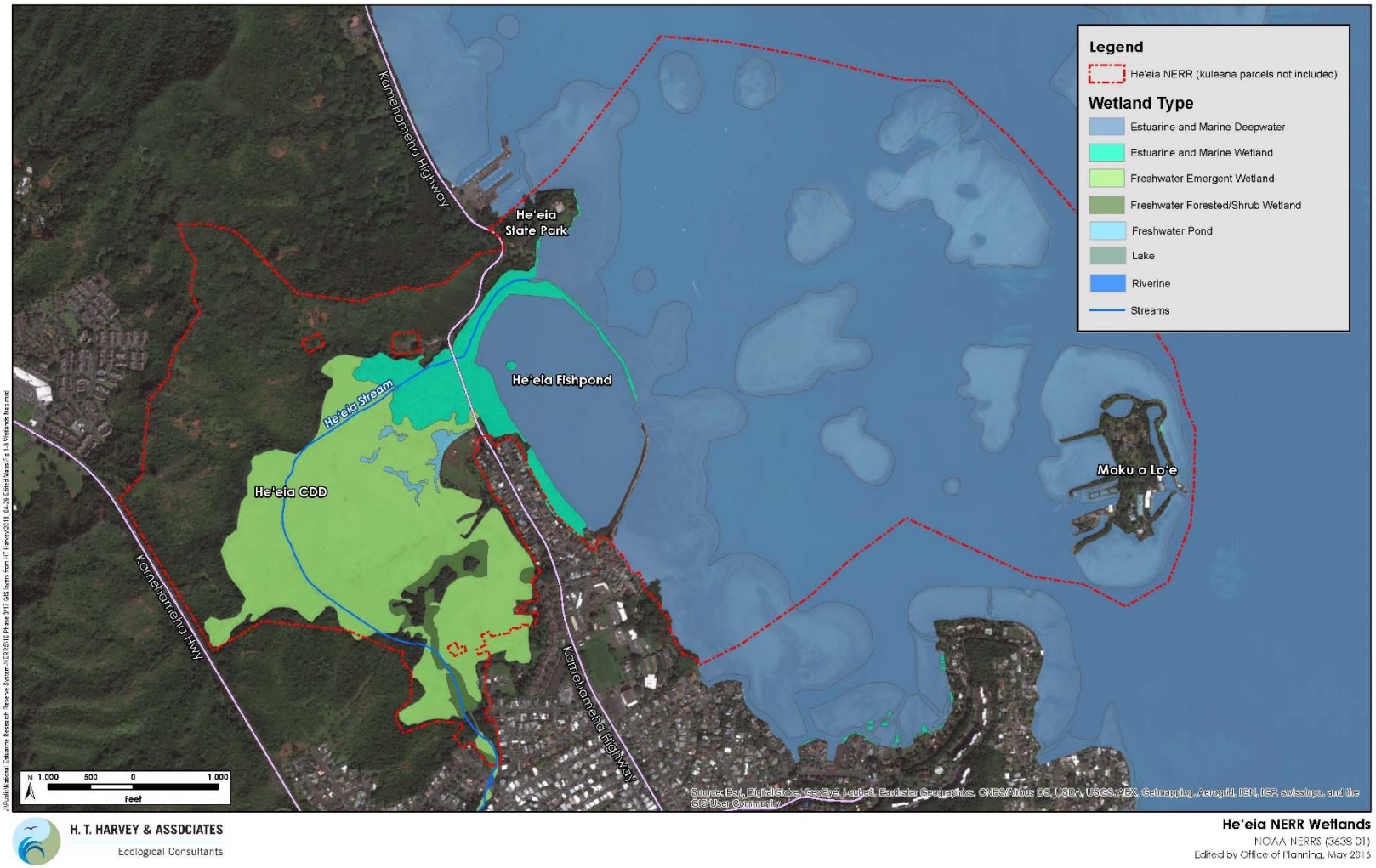

Figure 1.9. National Wetland Inventory (NWI) wetland types in the He'eia NERR

The marsh habitat consists mostly of the floodplain of He‘eia Stream and is extensively overgrown with California grass, which occludes open water areas (Calvin Kim and Associates 1990, Townscape 2011a, U.S. Department of Agriculture [USDA] 2011) (Figure 1-10). The marsh habitat is known to occasionally provide feeding and loafing habitat for four endangered waterbirds: Hawaiian gallinule (*Gallinula chloropus sandvicensis*), Hawaiian duck or koloa (*Anas wyvilliana*), Hawaiian coot (*Fulica alai*), and the Hawaiian stilt (*Himantopus mexicanus knudseni*). The dense growth of California grass in the He‘eia marsh is believed to have a significant negative impact on native waterbird habitat (Calvin Kim and Associates 1990, Townscape 2011b).

Figure 1.10. Dense growth of California grass (*Urochloa mutica*) in He‘eia wetland area

(Photo courtesy of H. T. Harvey & Associates)

Seasonally wet grasslands are located downslope of the floodplain, above the residential neighborhoods. They flood and become marshy in the rainy season, when they are covered by up to 1 foot of water (Calvin Kim and Associates 1990). Dominated by California grass, these seasonally wet grasslands also support a variety of nonnative facultative and obligate wetland plant species such as sedge (*Frimbristylis littoralis*), Job’s tears (*Coix lachrymal-jobi*), arrowhead (*Sagittaria sagittaefolia*), and kamole (*Ludwigia octivalvis*).

The freshwater forested/shrub type wetland occurs in a narrow belt around the upland habitat in the southern part of the He‘eia CDD. This forested/shrub type wetland comprises trees like java plum (*Syzygium cumini*) and shrub species such as cat’s claw (*Caesalpinia decapetala*), Cuba jute (*Sida rhombifolia*), koa haole (*Leucaena leucocephala*), and guava (*Psidium guajava*). At the southern boundary of the He‘eia NERR, where He‘eia Stream enters the He‘eia CDD, this wetland type supports a thick forest of hau trees (Townscape 2011a and b).

The freshwater pond is represented by natural open water ponds located above the mangrove forests (Figure 1-9). These ponds have mixed native and nonnative vegetation; native plants present include makaloa (*Cyperus laevigatus*) and neke (*Cyclosorus interruptus*) ferns (Townscape 2011a).

Fauna identified in the wetland habitats includes cane toad (*Pantala flavescens*); globe skimmer dragonfly (*Crocothemis servilia*) and three other dragonfly species (red, blue-green, and purple *Ischnura* spp.) near shallow stagnant water; a *Heteropoda* sp. cane spider; cyclid fish, mosquitofish, and crayfish in the demonstration loʻi and ponds; and mallard-koloa hybrid, Shama thrush (*Copsychus malabaricus*), and Pacific golden plover (*Pluvialis fulva*) (Townscape 2011a). Domestic ducks, black-crowned night herons (*Nycticorax nycticorax*), and cattle egrets (*Bubulcus ibis*) also have been recorded in waterbird surveys at the site (DOFAW unpublished data). Biannual waterbird counts conducted at Heʻeia marsh confirm that the site is used by all four endangered waterbirds, albeit in low numbers. Bullfrogs (*Rana catesbiana*) have been observed in small ponds in the seasonally wet grasslands (Calvin Kim and Associates 1990).

Kākoʻo ʻŌiwi, through its Māhuahua ʻAi o Hoi (Re-growing the fruit of Hoi) project (see Section 6.3.1), plans to establish a land management program to return the wetlands of Heʻeia, also known as "Hoi," to productive agricultural, cultural, and educational use. In cooperation with the Natural Resources Conservation Service (NRCS), the group has developed a detailed conservation plan (Townscape 2011b), the implementation of which is in progress. This work includes rehabilitating wetlands to loʻi kalo (Townscape 2011b) (Figure 1-11). The conservation plan comprehensively addresses concerns regarding the soil, water, animals, plants, and air resources involved in the rehabilitation of the loʻi kalo.

Figure 1.11. Taro patch in Heʻeia wetland area

(Photo courtesy of H. T. Harvey & Associates)

1.3.1.3 Freshwater Stream

The He‘eia Stream is listed in the Hawai‘i Stream Assessment (Parham et al. 2008) as a small perennial stream containing moderate aquatic resources. In ranking streams according to a suite of ecological diversity and resilience factors, Parham et al. (2008) assign streams a standardized score from 1 to 10, with 1 being the poorest and 10 being the best. He‘eia Stream received a Stream Biological Rating of 4, and is noted to contain moderately important biological resources that include diverse native and introduced macrofauna (Townscape 2010). The stream goby, *Awaous guamensis* (‘o‘opu nākea) (Figure 1-12), was identified as occurring in the stream, as well as seven other native aquatic (fish) species and five introduced species (Townscape 2011a). Largest of the Hawaiian gobies, *A. guamensis* is the only one of the five species of ‘o‘opu that is not endemic to the Hawaiian Islands. This species is also found in Guam, New Caledonia, Vanuatu, and Fiji, and is considered indigenous in Hawai‘i.

In 2001–2003, the Hawai‘i Biological Survey examined the lower reaches and nearshore estuarine waters of He‘eia Stream and documented a total of six fish species: the endemic flagtail (*Kuhlia xenura*) and flathead gray mullet (*Mugil cephalus*); the indigenous great barracuda (*Sphyraena barracuda*); and the introduced western mosquitofish (*Gambusia affinis*), shortfin molly (*Poecilia mexicana*), and tilapia (*Tilapia melanothera*) (Englund et al. 2003). Only two species of insect were documented by Englund et al. (2003), one of these being the indigenous dragonfly (*Pantala flavescens*). Parham et al. (2008) report

Figure 1.12. Indigenous stream goby ‘O‘opu Nākea (*Awaous guamensis*)

(Photo courtesy of Annette Tagawa, Division of Aquatic Resources)

15 fish species and the endangered blackline Hawaiian damselfly (*Megalagrion nigrohamatum nigrolineatum*) to occur in He‘eia Stream, based on eight surveys conducted in the lower and middle sections of the stream between 1975 and 2003. Low aquatic insect diversity may be attributed to the high-salinity environment of lower He‘eia Stream.

1.3.1.4 Estuarine and Coastal

The upper intertidal areas of the He‘eia NERR, including the seaward portion of the He‘eia Fishpond and lower reaches of He‘eia Stream (Figure 1-6), are dominated by mangroves and estuarine mudflats, and are inundated by fresh water from He‘eia Stream and by seawater when the tide is high (Figure 1-13). Large fluctuations in water quality in the estuary cause abrupt changes in dissolved oxygen, pH, salinity, and temperature (Jokiel 1991). These areas function as breeding and nursery habitat for marine life and attract many resident coastal species that are tolerant of changes in salinity.

Red mangrove (*Rhizophora mangle*) is the dominant species, followed by the *Bruguiera* species *B. sexangula* and *B. gymorhiza.* The mangroves capture sediment and organic material that are transported downstream and deposited in the estuary, creating a silty mud bottom along the coast. The expansion of mangroves and deposition of sediments over time has reduced the estuarine environment and altered water flow patterns with respect to both the stream channel locations and the extent of tidal incursions. Although the mangroves are not native, they are known to harbor a variety of marine and estuarine organisms that are sought for bait and food. The habitat provided by the mangrove prop roots and associated fouling assemblages (e.g., algae, invertebrates) provide habitat for juvenile fish which, as adults, populate freshwater or marine environments (Calvin Kim and Associates 1990, Brooks 1991).

Figure 1.13. Mangrove invasion of estuarine habitat in lower reaches of He‘eia Stream

(Photo courtesy of H. T. Harvey & Associates)

The expansion of mangroves has also substantially reduced the area of marshland habitat once used by native waterbirds (Calvin Kim and Associates 1990, Brooks 1991, Helbert Hastert & Fee 2007). The USFWS recovery plan for endangered waterbirds describes He‘eia as a site that historically had value as a

complex of tidal marshes and open water areas, but which has been substantially modified and presently consists of nonnative mangroves, remnants of ponds, and wet pasture. The recovery plan recommends that He‘eia be restored and managed by the state to provide enhanced habitat for endangered waterbirds (USFWS 2011).

Kāko‘o ‘Ōiwi, through its Māhuahua ‘Ai o Hoi Project, and after a required environmental review process, plans to remove approximately 20 acres of the mangroves that are choking the stream channel and to replace them with native plants such as baby tears (ae‘ae, *Bacopa monnieri*), many spike flat sedge (*cyperus polystachios*), java sedge (ahu awa, *cyperus javanicus*), pili grass (*Heteropogon contortus*), and sea purselane (akulikuli, *Sesuvium portulacastrum*) that will serve as habitat for birds and as a nursery for juvenile fish (Townscape 2011a, 2011b). The endangered Hawaiian hoary bat likely roosts in the mangroves (Helber Hastert & Fee 2007), so removal of the mangroves will be conducted outside of the bat’s breeding season to avoid impacts on the species.

Migratory shorebirds are found in the He‘eia NERR and use the coastal habitats, estuaries, marshes, wetlands, and grasslands in the area. The limited lawn habitat in the He‘eia NERR could be used by the Pacific golden plover (Helber Hastert & Fee 2007). The *Pacific Islands Shorebird Conservation Plan* (Engilis and Naughton 2004) identifies Kāne‘ohe Bay as an important tidal flat used by flocks of shorebirds that forage at low tides. The plan also identifies tidal flats where mangroves have been effectively removed as providing positive benefits to shorebirds.

Figure 1.14. He‘eia Fishpond

(Circa 2011- Copyright: Kalei Nu‘uhiwa)

He‘eia Fishpond, an 88-acre seashore pond is located at the center of the He‘eia NERR and is completely surrounded by a rock wall (Figure 1-14). The waters of the pond receive freshwater inputs from He‘eia

Stream, which drains the He‘eia watershed and empties into the northwestern corner of the fishpond. The fishpond retains a brackish character resulting from tidal flux of seawater from the adjacent Kāne‘ohe Bay. Water flows into and out of the fishpond are regulated by a series of eight sluices. The pond has been used primarily as a site to promote aquaculture using traditional cultural practices of resource management (Helber Hastert & Fee 2007).

Fish species that live in the He‘eia Fishpond and adjacent fresh and estuarine waters include Hawaiian ladyfish (‘ama‘ama, *Elops hawaiensis*), milkfish (awa, *Chanos chanos*), Dussumier’s surgeonfish (palani, *Acanthurus dussumieri*), flagtail (āholehole, *Kuhlia* spp.), threadfin (moi, *Polydactylus sexfilis*), porcupinefish (kokala, *Diodontidae*), barracuda (kākū, *Barracuda barracuda*), mullet (‘ama‘ama, *Mugil cephalus*), and juvenile trevally (pāpio, *Carangidae*). The waters of the fishpond also contain various species of brackish water shrimp (‘ōpae, *Atyidae*), moray eel (puhi, *Gymnothorax* spp.), and mollusks (invertebrate animals in the Phylum: Mollusca) (Townscape 2010, Paepae o He‘eia 2013).

1.3.1.5 Marine

The coastal waters of Kāne‘ohe Bay are influenced by a combination of estuarine and marine processes, and support a dynamic ecological structure composed of diverse assemblages of marine invertebrates, coral, and fish. The He‘eia NERR’s open waters are located between the southeastern and central sections of Kāne‘ohe Bay; the waters in this area are characterized by relatively high rates of freshwater input and slower overall rates of circulation.

Three distinct physiographic zones that define the marine environment of Kāne‘ohe Bay were described by Jokiel (1991)—inshore, inner bay, and outer bay. Most of the inshore area is fronted by shallow fringing reef <3.3 feet deep that extends 1,640–2,460 feet off shore (Figure 1-15). Seaward of this fringing reef and the intertidal zone lie the inner bay and lagoon, which include patch reefs containing rich coral colonization, algal communities including invasive algae, and sand and sea grass beds. The inner bay waters support abundant planktonic organisms (Smith et al. 1981, Taguchi and Laws 1987, Ringuet and Mackenzie 2005) and a diverse assemblage of reef-associated and pelagic fish species (Jokiel 1991, Hunter and Evans 1995). The inner bay receives considerably more oceanic enrichment than do the inshore waters because of its physiography relative to the open ocean. The outer bay is fronted by a barrier reef complex that slopes gently seaward and receives considerable marine nourishment, owing to wind-driven mixing of surface waters and transport of deeper oceanic waters into the bay.

In total, about 25% of the more than 6,500 currently described species of Hawaiian coral reef organisms are endemic (Fautin et al. 2010), and many of these are found among the diverse habitats of Kāne‘ohe Bay (Figure 1-16). Kāne‘ohe Bay is considered an outstanding world-class scientific and field research setting because of the complex patch reef structure, fringing reef that extends the landward margin, well-flushed lagoon, and diversity of habitats and organisms present (Bahr et al. in prep.).

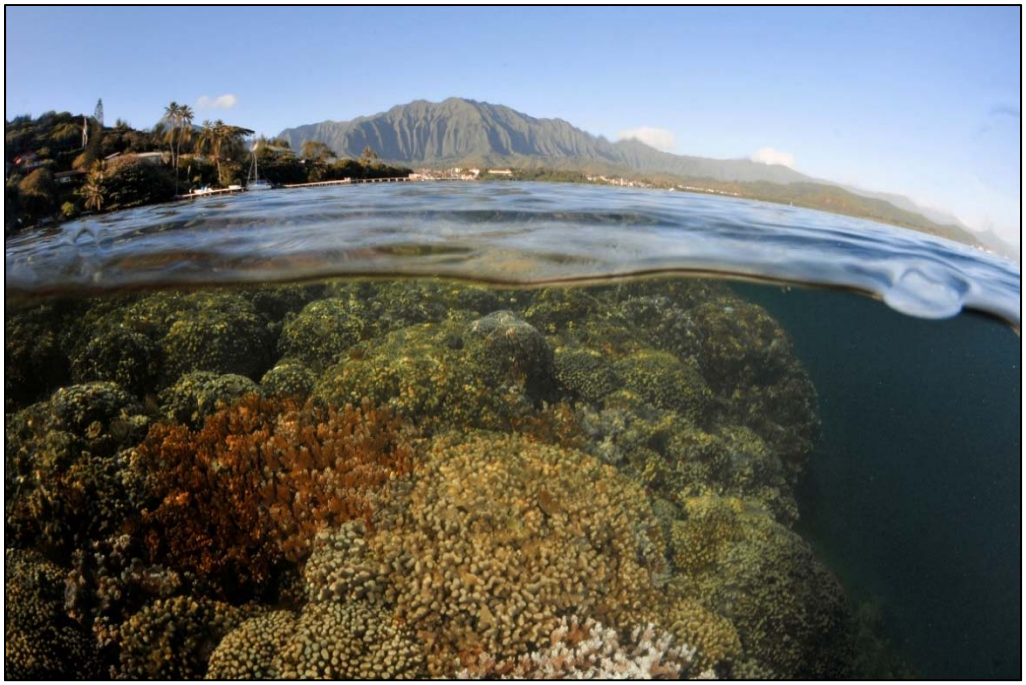

Figure 1.15. Shallow fringing reefs in Kāneʻohe Bay

(Photo: Copyright Andre Seale)

Figure 1.16. Tropical coral reef habitat in Kāneʻohe Bay

(Photo courtesy of Hawaiʻi Institute of Marine Biology)

1.3.2 Watershed and Hydrology

The He‘eia watershed totals 3.5 square miles (2,240 acres) (Parham et al. 2008) and extends beyond the boundaries of the He‘eia NERR, up the Ha‘ikū and He‘eia valleys, to the peak of the Ko‘olau Mountains. Ha‘ikū and ‘Ioleka‘a Streams merge to form the perennial He‘eia Stream, which runs through the He‘eia NERR. This watershed includes lands that are zoned for urban, agricultural, and conservation uses. Figure 1-17 depicts the boundary of the watershed and the location and extent of the different land use types in He‘eia.

One of the unique attributes of the He‘eia NERR is that the watershed and ahupua‘a[3] are close and accessible to the community and researchers. The total length of He‘eia Stream from the top of the forested upper reaches of the watershed to the end of the stream mouth as it enters Kāne‘ohe Bay is only 7.1 miles (Parham et al. 2008). One can stand at the mouth of the stream and look up to see the origins of the stream and watershed at the top of the Ko‘olau Mountains.

Groundwater resources in the He‘eia NERR were described in the Kāko‘o ‘Ōiwi Conservation Plan (Townscape 2011):

> The aquifer beneath the proposed site is within the Ko‘olau Poko Aquifer System of the Windward Aquifer Sector. This aquifer mainly consists of high level dike-impounded groundwater. There are many groundwater seeps and springs in the wetlands of He‘eia. The property area is located on the ocean side of the HIDOH [Department of Health] Underground Injection Control (UIC) Line. There are no groundwater wells located onsite or in the vicinity of the property. The nearest groundwater wells are located in Upper Ha‘ikū Valley, on the mountainside end of He‘eia watershed. These wells are not listed as having contaminants.

He‘eia watershed quality is considered “impacted” owing to the amount of impervious surfaces (18.41%), and most of the impervious surfaces (in the form of high-intensity development) are located just upstream of the He‘eia NERR (Kailua Bay Advisory Council 2007) (Figure 1-17). Discharge records from He‘eia Stream at Ha‘ikū Valley, approximately 0.5 mile upstream of the He‘eia NERR, indicate that high flows occur regularly in the watershed (U.S. Geological Survey [USGS] 2015) (Figure 1-18), and associated erosion and sedimentation are a concern for both the watershed and health of Kāne‘ohe Bay. Coral health in the bay in particular has been negatively affected by nutrients and sediment-rich freshwater inputs (Guidry et al. 2013).

Actions that are part of the Kāko‘o ‘Ōiwi Māhuahua ‘Ai o Hoi Project (“Re-Growing the fruit of Hoi”) are likely to benefit the watershed and hydrology of the area. Invasive plants, such as California grass and other

[3] See “Ahupua‘a: A Cultural Orientation,” at the beginning of this management plan for a detailed description of this concept.

nonnative plants that are constricting flows in the He‘eia Stream channel are being removed, along with invasive mangrove trees in the upper intertidal area and fishpond, which are acting as a sediment trap, filling the fishpond and contributing to destabilization of the fishpond walls (Townscape 2011a). Also, there are plans to create detention ponds just above the wetlands in the southern portion of the He‘eia NERR, to help detain sediments and debris during storm events and thus reduce impacts on wetlands and agricultural areas (Townscape 2011a).

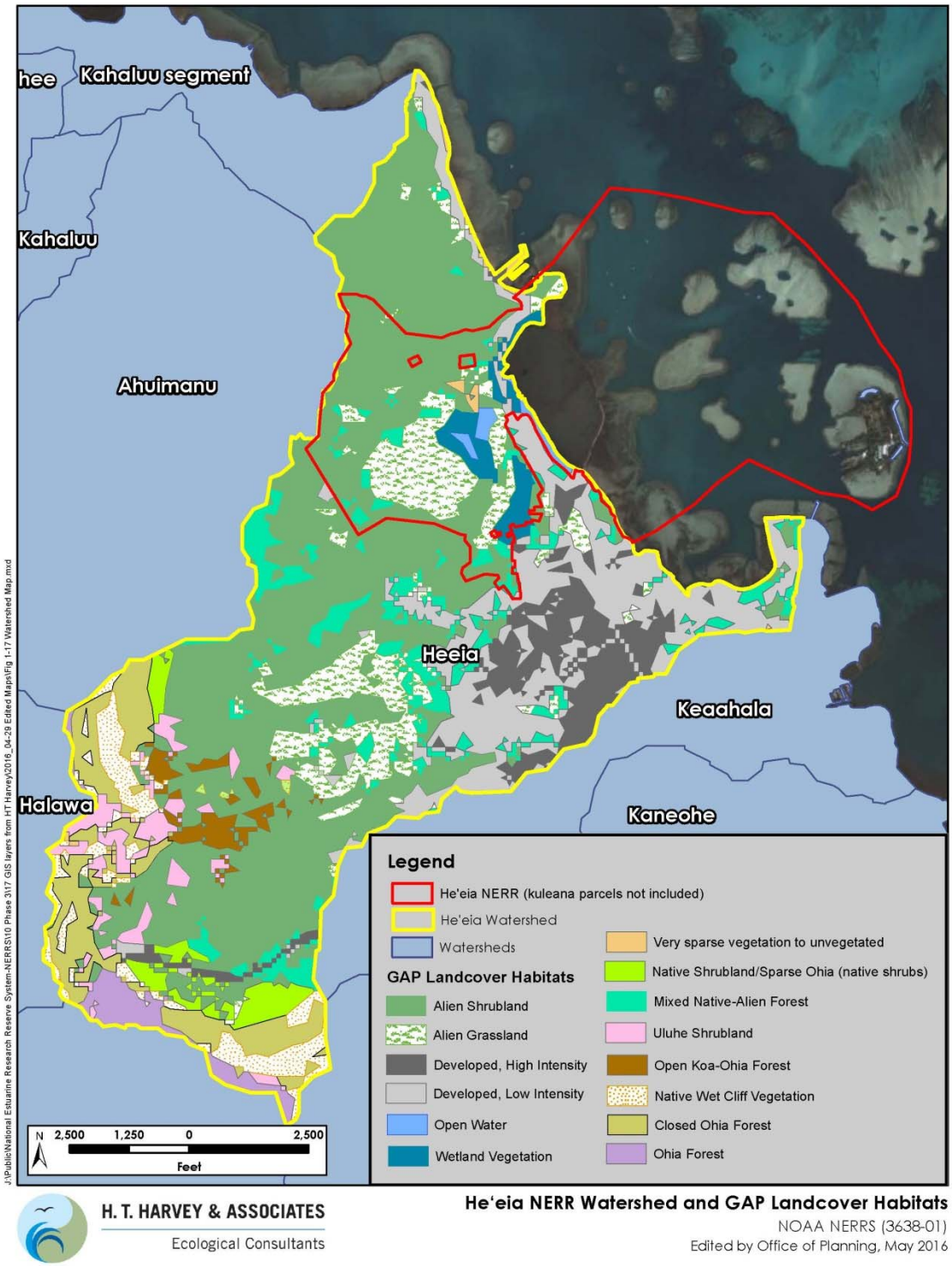

Figure 1.17. Land Cover Types in the He'eia Watershed

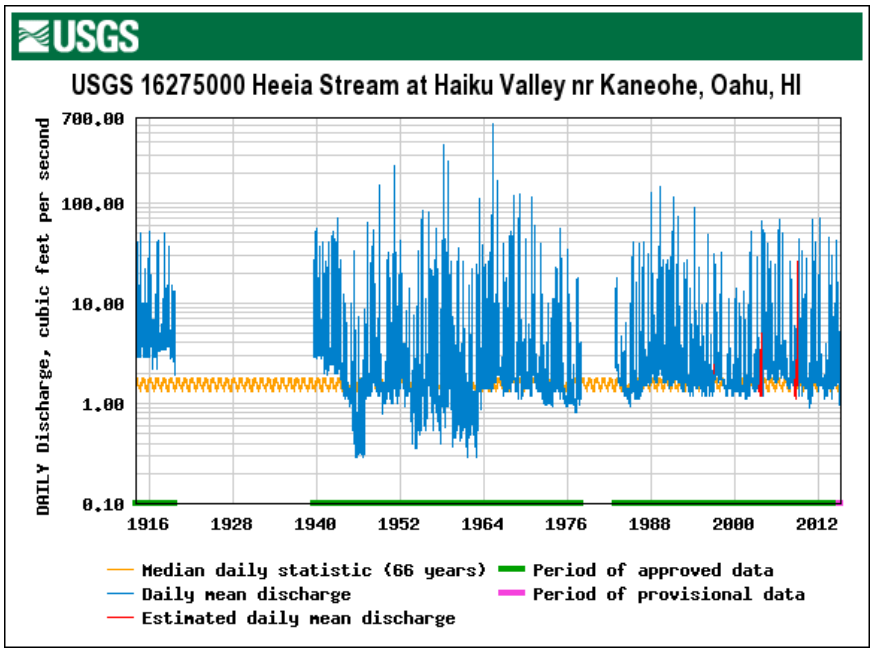

Figure 1.18. Daily discharge of fresh water from He‘eia Stream (in cubic feet per second) near Kāne‘ohe, 1914-2014

(U.S. Geological Survey 2015)

1.3.3 Water Quality

The water bodies in the He‘eia NERR consist of the perennial He‘eia Stream, the estuary, He‘eia Fishpond, and the semi enclosed Kāne‘ohe Bay (Figure 1-6). Water quality in these water bodies is important, because it affects the health of fish and coral populations in the bay, the quality of drinking water on land, and the resilience of natural water systems in the face of climate change.

Observed water quality impairment in the He‘eia NERR likely originates in the uplands. Runoff from uplands may include sediments naturally eroding from forestlands; nitrates from fertilizer runoff, septic tanks, sewage, or erosion of natural deposits; and pollutants from urban development and road construction (Sumiye 2002). Nutrient and sediment-rich fresh water runs off into Kāne‘ohe Bay, especially during storm events, which induces phytoplankton blooms and threatens the health of the coral reefs in the bay (DeCarlo et al. 2007, Drupp et al. 2011, Guidry et al. 2013).

HIDOH is required by Clean Water Act (CWA) Section 303(d) to report on the state’s water quality on a 2-year cycle, and to submit a list of waterbodies that do not meet state water quality standards, plus a priority ranking of listed waters for total maximum daily load (TMDL) development, based on the severity of pollution and the uses of the waters (HIDOH 2014). Both He‘eia Stream and Kāne‘ohe Bay are on the list for nonattainment of one or more of the water quality standards, so their status is reported on a 2-year cycle

(HIDOH 2014). As of 2014, He‘eia Stream had not met the standards for nitrate+nitrite-nitrogen (NO_3+NO_2) and total phosphorus (TP) during both the wet and dry seasons, but had attained the standard for turbidity, total suspended solids (TSS), and total nitrogen (TN) (HIDOH 2014). Kāne‘ohe Bay (Central Region, in the He‘eia NERR) had not met the standards for TN, NO_3+NO_2, ammonia-nitrogen (NH_3), and turbidity, but there was insufficient data to evaluate bacteria, TP, and chlorophyll-*a* (chl-a) (HIDOH 2014). As of November 2016, the HIDOH draft Integrated Report reports that Heeia Stream is still listed for total nitrogen (dry season only) and nitrate + nitrite (both wet and dry seasons). Kāne‘ohe Bay (Central Region, in the He‘eia NERR) is listed for total nitrogen, nitrate + nitrite, ammonium, and turbidity for the wet season.

Since 2012, He‘eia has been a priority watershed under HIDOH’s Clean Water Branch (CWB) Polluted Runoff Control Program (PRCP). The PRCP has funded projects in He‘eia under the Clean Water Act (CWA) Section 319 that aim to reduce sediment and nutrients in the watershed. Additional projects are planned in the watershed to contribute to the goal of delisting He‘eia Stream for at least one pollutant by 2020. Water quality monitoring in He‘eia Stream is also planned until 2020 (DOH CWB 2015). In order to ensure monitoring and restoration efforts are coordinated, the He‘eia NERR will actively engage with the PRCP and monitoring and analysis sections of the CWB during the development and implementation of the He‘eia NERR monitoring program.

1.3.4 Geology

The He‘eia NERR is located on the windward side of the Ko‘olau Mountains, which are characterized by steep cliffs and short ridges less than 4 miles long, topography that contributes to rapid runoff and low infiltration (Ko‘olau Mountains Watershed Partnership 2002). The soils in the He‘eia NERR, at the base of these mountains, are described below.

The soils in much of the He‘eia wetlands are comprised mostly of Hanalei silty clay (HnA) and Marsh soils (MZ) (Townscape 2011a) (Figure 1-19). In a typical profile, Hanalei silty clay is composed of poorly drained silty clay and silty clay loam from 0 to 36 inches in depth. This clay is frequently flooded and occasionally ponded, and has a moderate available water capacity. Marsh soil is composed of mucky peat from 0 to 60 inches in depth. It is very poorly drained, frequently flooded and ponded, and has a very high available water capacity.

The uplands to the north of the wetlands were characterized as Waikāne silty clay, with slopes of 25 to 40% (WpE) and ‘Alaeloa silty clay, with 15 to 70% slopes (AeE and ALF). The hillside soils are silty and well drained, although they have less water capacity than the soils in the wetlands and are classified as highly erodible. Landslide areas are visible on the hillsides, and sheet/rill and road erosion are a concern (Townscape 2011a).

The shoreline of Kāneʻohe Bay is ringed by shallow fringing reefs, and the bay has numerous patch reefs that occur less than 3.3 feet from the surface and are partially exposed during extreme spring tides (Jokiel 1991). As discussed, several of these patch reefs are located in the Heʻeia NERR. The bottom of Kāneʻohe Bay consists of coral rubble, gray coral muds, and fine coral sands, with fine brown silts and clays nearshore, especially near stream mouths (Jokiel 1991). Four major islands and islets are located in Kāneʻohe Bay: Kapapa, Mokoliʻi (Chinaman's Hat), Kekepa (Turtleback Rock), and Moku o Loʻe. The 28-acre Moku o Loʻe is the only one of the four that is situated in the Heʻeia NERR; this island is a basaltic outcrop formed by the old Koʻolau volcano and is surrounded by fringing reefs (Jokiel 1991).

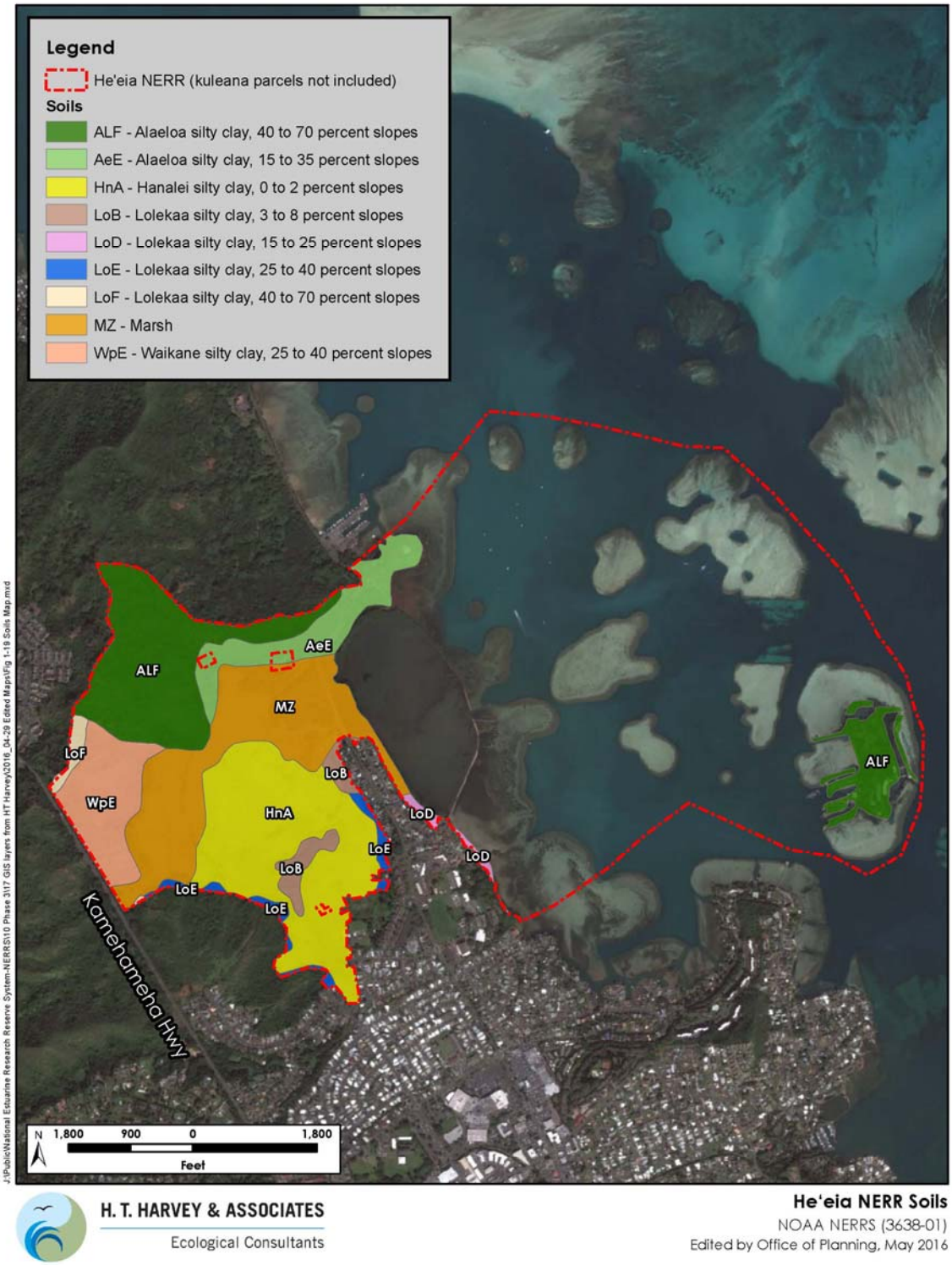

Figure 1.19. Soil Map of He'eia NERR

1.3.5 Climate

The He‘eia NERR is located on the windward side of O‘ahu, which experiences cooler temperatures and higher rainfall than the leeward side of the island. Trade winds from the northeast bring warm moist air to land. The moisture is deflected up along the Ko‘olau Mountains, where the warm air cools, forms clouds, and releases rain. The mountains above the He‘eia NERR experience frequent rainfall, whereas the coastal areas receive moderate to frequent rainfall (Giambelluca et al. 2013) (Figure 1-20), most of which occurs from October through May, with occasional heavy storms. The average annual air temperature ranges from 71 to 85°F, averaging 78°F (U.S. Climate Data 2015).

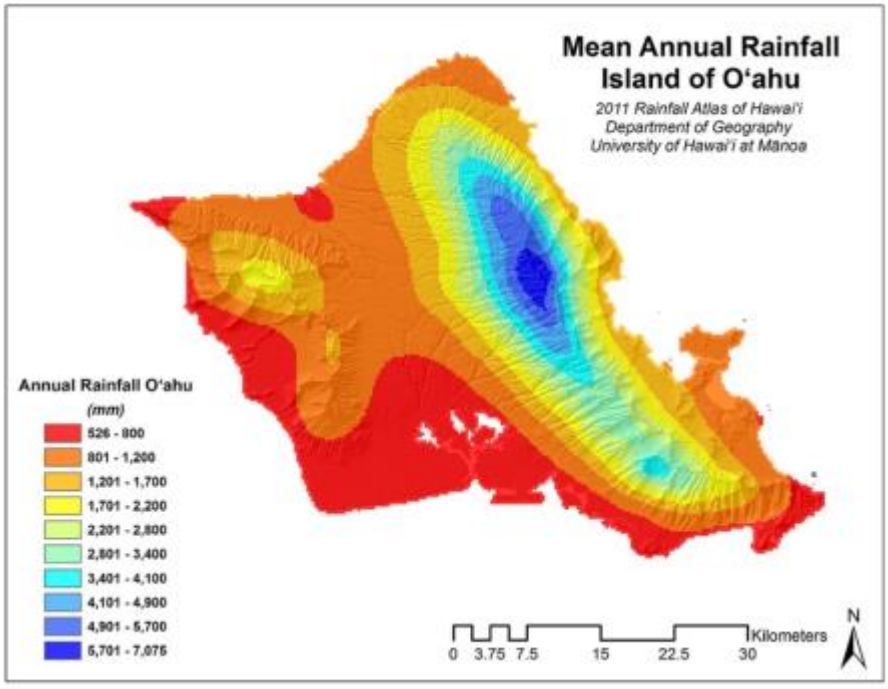

Figure 1.20. Mean Annual Rainfall on the Island of O‘ahu

(Giambelluca et al. 2013)

Climate change in the Hawaiian Islands has been observed and is predicted to continue in the form of rising sea surface and air temperatures, sea level rise, ocean acidification, and declining rainfall and streamflows, with more of the rainfall occurring in intense downpours (Codiga and Wager 2011, Nurse et al. 2014). Ocean acidification, caused by rising atmospheric carbon dioxide concentrations and subsequent increases in dissolved inorganic carbon and carbon dioxide in ocean waters, may reduce the recruitment rate and growth of corals in Kāne‘ohe Bay (Jokiel et al. 2008, Kuffner et al. 2008). Sea level rise, which is predicted to be approximately 1 foot by 2050 and 3 feet by 2100 (Codiga and Wager 2011), could result in saltwater intrusion into the He‘eia wetlands and taro lo‘i, and may overtop the fishpond walls. Changes in rainfall

patterns to more intense downpours could affect hydrology and decrease water quality in Heʻeia Stream and Kāneʻohe Bay.

Methane emissions from the Heʻeia wetlands could exacerbate climate change impacts—wetlands are a natural source of methane, which is a greenhouse gas (Mitsch et al. 2013). However, tropical wetlands are predicted to function as a net carbon and radiative sink within the next 300 years and balance out the methane emissions (Mitsch et al. 2013). The Heʻeia wetlands may also provide a natural flood buffer that accommodates sea-level rise without the need for additional hard armoring or other measures to protect upstream urban development (Codiga and Wager 2011). Therefore, the Heʻeia wetlands may increase the overall resilience of the ecosystem to climate change.

1.4 Archaeological and Cultural Resources in Heʻeia NERR

The ahupuaʻa of Heʻeia is located in the moku (district) of Koʻolaupoko. It is bounded by the ahupuaʻa of Kahaluʻu in the north and by Kāneʻohe in the south and extends eastward across Kāneʻohe Bay to include the tip of the left lobe of the Mōkapu Peninsula and also Moku o Loʻe (Coconut Island) (Cruz and Hammatt 2012) (Figure 0-2).

The mountainous section of the ahupuaʻa is marked by the stunning Koʻolau cliffs, heiau (places of worship), and caves. Puʻu Keahiakahoe (the first of Ka-hoe Hill) is the tallest puʻu (peak) on the Koʻolau overlooking the ahupuaʻa of Heʻeia and Kāneʻohe. Along the cliffs lived the earth goddess, Kāmehaʻikana, who lived in a cave named Kaualehu (the ash rain). The cave is believed to have once contained burials and is visible from the site of a former heiau called Kahekili (the thunder), of which a solitary stone remains today (Cruz and Hammatt 2012).

The valley of Haʻikū at the base of the Koʻolau mountains is an area rich in springs and streams, which allowed the loʻi kalo (irrigated taro terraces) to flourish. The gods Kāne and Kanaloa obtained their drinking water from a spring called Kapuna, and the abundant fresh water irrigated the loʻi kalo. At the bottom of the ʻIolekaʻa pali (cliff) is a pool associated with the legendary rat called ʻIolekaʻa (rolling rat) (Cruz and Hammatt 2012).

The coastal waters of Kāneʻohe Bay once contained at least thirty loko iʻa (fishponds), including the Heʻeia Fishpond. The kiaʻi (guardian) of the Heʻeia Fishpond, Meheanu, lived on a small nearby section of the land called Luamoʻo (lizard water spirit pit) and had the power to change herself into a moʻo (lizard) or a puhi (eel), depending on the color of the hau (hibiscus) thickets. Hawaiians regarded Kealohi Point (the shining) as a leina ʻuhane (leap of the soul), a place where the souls of the dead leap into the sea. The west side of the peninsula of Mōkapu (sacred island) belonged to the ahupuaʻa of Heʻeia and included fishing koʻa (shrines) (Cruz and Hammatt 2012).

Beyond the rich moʻolelo of the area, the Koʻolaupoko moku and, in particular, the ahupuaʻa of Heʻeia sustained a dense population (Cruz and Hammatt 2012) based on a robust and flourishing agricultural and aquacultural community. Owing to the frequent rainfall, abundant water resources, and flatlands, the area also is known to have contained the most extensive early wetland agricultural complex on Oʻahu.

The Mahele (land division) records indicate that the area included numerous shoreline fisheries and extensive loʻi kalo. Between the 1840s and 1850s, more than 60 land commission awards were issued for the area, reflecting the ability of this ahupuaʻa to support a vibrant and self-sustaining community.

Heʻeia is associated with wahi pana (sacred places), akua kiaʻi (guardians), demigods, and goddesses (Appendix B). Traditional accounts and several former and existing archaeological features such as burial grounds and heiau also indicate the cultural significance of the ahupuaʻa of Heʻeia as a favored and important place during traditional Hawaiian times.

The Heʻeia NERR site has been subject to numerous archaeological and cultural resource studies (McAllister 1933, Yent and Griffin 1977, Kawachi 1990, Nagata 1992, Henry 1993, Freeman and Hammatt 2004, Carson 2006, Altizer 2011, Cruz and Hammatt 2012, Groza and Monahan 2012, Soltz et al. 2014). McAllister (1933) was the first to document the major sites around Oʻahu in 1933; with regard to Heʻeia, he documented three cultural sites: Heʻeia Fishpond, Kaualaukī Heiau, and the dwelling place of Meheanu at Luamoʻo.

The Heʻeia Fishpond was listed on the National Register of Historic Places (50-80-10-327) in 1973. However, an inventory of historically and culturally significant areas in and immediately around the fishpond boundaries identified no specific cultural resources other than the fishpond itself (Cruz and Hammatt 2012). Archaeological assessment of the replacement of the caretaker's house at Heʻeia Fishpond also did not identify any surface or subsurface cultural resources (Carson 2006). A literature review and field inspection for a Heʻeia Fishpond wall repair project identified no potential adverse effects on cultural resources and recommended no further archaeological work (Groza and Monahan 2012). A separate cultural impact assessment (CIA) done for the Heʻeia Fishpond involved community consultation and formal interviews (Cruz and Hammatt 2012). This CIA discussed the important relationship between Heʻeia Fishpond and inland taro loʻi, which mitigated the effects of flooding on the fishpond. The CIA also discussed that the fishpond may include Traditional Cultural Properties (TCPs) of ongoing cultural significance, which may be included in the State Historic Register. The CIA concluded that the fishpond wall repairs would not adversely affect cultural practices and resources.

Surface and subsurface archaeological surveys of Heʻeia State Park in 1977 (Yent and Griffin 1977) did not report any significant findings. However, relevant to the area, a 1982 report documented iwi (ancestral remains) at Heʻeia State Park, which was confirmed by a 1992 (Nagata 1992) archaeological survey of the same parcel. An archaeological and cultural impact study conducted for the Kamehameha Highway

waterline project did not identify any historical properties or traditional cultural practices, and Keʻalohi Point was noted as leina ʻuhane (leap of the soul) (Freeman and Hammatt 2004).

Literature and field review for portions of the Kakoʻo ʻŌiwi Māhuahua ʻAi o Hoi project ("Re-Growing the fruit of Hoi") documented a precontact (i.e. predating 1778) basalt quarry, the foundation of an ʻōkolehao distillery, two ranching enclosures, fences and roads possibly related to agriculture, and possible subsurface loʻi berms (Altizer 2011). Work conducted at the Kakoʻo ʻŌiwi property identified the following 17 sites (Soltz et al. 2014) (Figure 1-21):

- Site 7521, plantation-era road
- Site 7522, basalt quarry with traditional debitage
- Site 7523, concrete foundation, possibly for ōkolehao distillery
- Site 7524, ranching-era enclosure
- Site 7525, ranching-era enclosure
- Site 7526, glass and ceramic fragment scatter
- Site 7527, glass and ceramic fragment scatter and three depression features
- Site 7528, four plantation-era depressions with glass and ceramic fragments
- Site 7529, stone and mortar L-alignment
- Site 7530, complex of five terraces and two mounds
- Site 7531, World War II–era earthen terrace and foxhole depressions
- Site 7532, plantation-era road, possibly to/from rice mill
- Site 7533, plantation-era bridge
- Site 7534, plantation-era ʻauwai
- Site 7535, two concrete platforms/foundations, possibly for rice mill
- Site 7536, ranching-era wooden and metal cattle run
- Site 7537, subsurface loʻi and rice berms

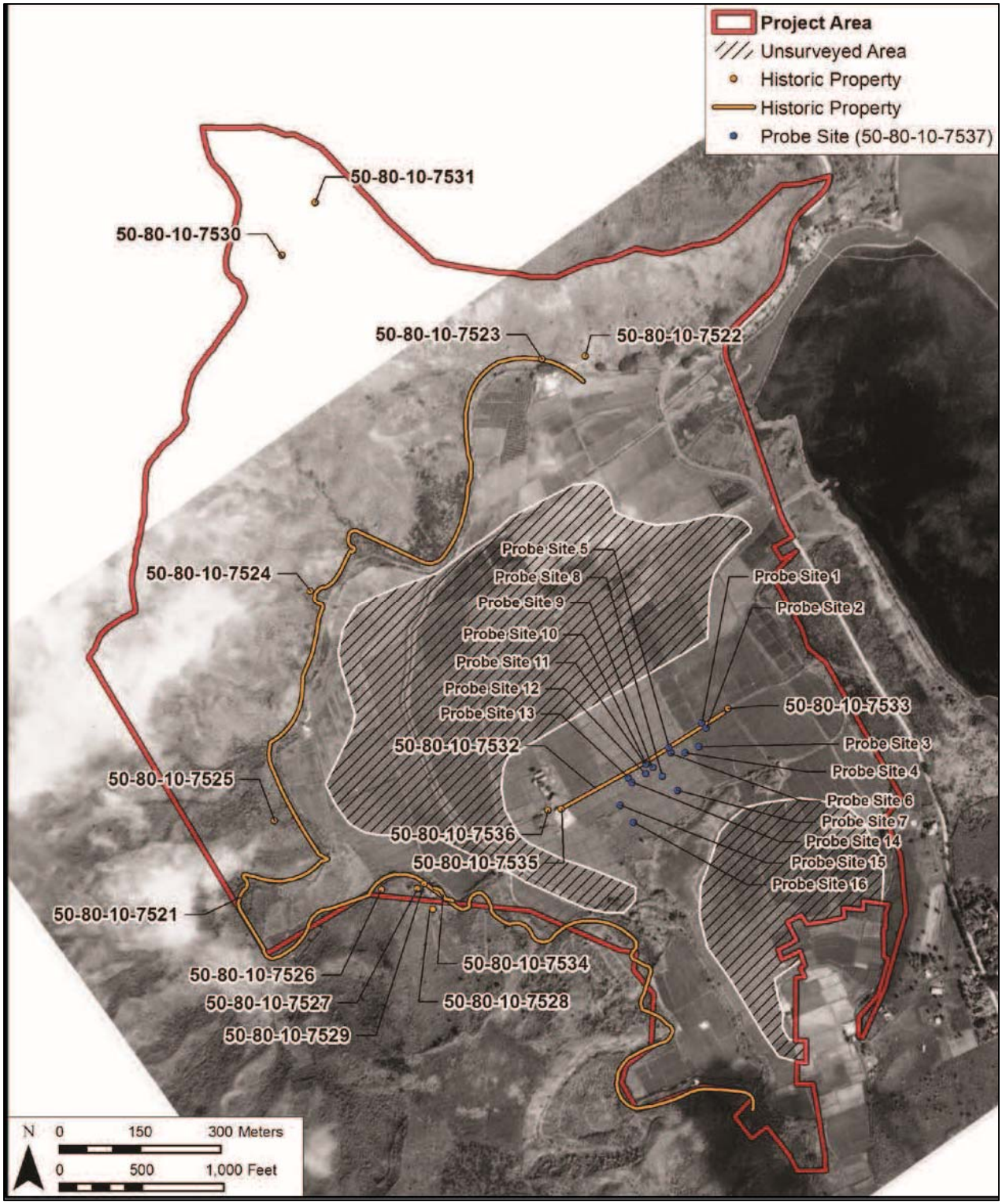

Figure 1.21. Location of archaeological features found in Kakoʻo ʻŌiwi managed lands in Heʻeia CDD

(From Soltz et al. 2014)

Four of these sites: the basalt quarry (Site 7522) and an agricultural complex (Site 7530), both of which predate the first arrival of Europeans sailors in 1778; and the postcontact (i.e., postdating 1778) remains of a rice mill (Site 7535) and an ōkolehao distillery have the potential to be affected by ongoing restoration and habitat manipulation activities by Kakoʻo ʻŌiwi (Site 7523) (Figure 1-21). The rehabilitation of the loʻi kalo includes the rehabilitation of historical roads in order to access these areas. However, any activities proposed in the area containing archeological resources will need to undergo necessary environmental review to ensure that the cultural and archeological sites are protected.

1.5 Socioeconomic Attributes of Heʻeia NERR

1.5.1 Kāneʻohe

For this account of the socioeconomic attributes of the Heʻeia NERR area, the *surrounding community* is defined as the Kāneʻohe Zip Code Tabulation Area (ZCTA). That area includes all the land surrounding Kāneʻohe Bay except for the Marine Corps base that occupies the Mōkapu Peninsula.

The lands surrounding Kāneʻohe Bay, from Kāneʻohe to Kualoa, include nine ahupuaʻa. The ahupuaʻa of Heʻeia extended from the cliffs at the headwaters of Haʻikū and ʻIolekaʻa Streams across the bay to part of the Mōkapu peninsula. Now, Heʻeia is commonly viewed as located within Kāneʻohe.

The Koʻolaupoko region, in which Kāneʻohe is situated, became suburban after World War II, when tunnels and routes through the Koʻolau Mountains connected Kāneʻohe and Kailua with Honolulu. Residential construction took off in the 1960s. In the Heʻeia area (Tax Map Key [TMK] 1-4-6), homebuilding peaked in the 1970s, as the inventory of current homes in (Figure 1-22) indicates. Plans for further urban development in Heʻeia and valleys to the north were put forward in this period, but were opposed by Heʻeia and Waiāhole–Waikāne-area residents.

1.5.1.1 Population

Demographic characteristics of residents of the Kāneʻohe ZCTA are shown in Table 1-2, and based on data from the American Community Survey (ACS) for 2009 through 2013.[4] Comparing the demographic profiles of the ZCTA with those of the City and County of Honolulu as a whole brings out distinctive qualities of the local population:

- Kāneʻohe's age structure is fairly old, with a median age of 41.5 years old.

[4] The ACS is a survey of a sample of the population, conducted every year. Results are published for 1-, 3-, and 5-year periods. Results are made available for smaller areas such as ZCTAs and census tracts using 5-year samples. The most recent data are for 2009 through 2013. Because the ACS is based on samples, it is not a count of the entire population at any one time, comparable to the decennial census. On the other hand, it is less affected by short-term conditions, such as the recession that lasted until 2010.

- Nearly all residents are Hawai‘i-born.
- The ethnic mix of the population is similar to that in the state as a whole.

Table 1-3 shows household characteristics. Renters form a smaller share of the population in Kāne‘ohe than in the State. However, the proportion of renters with high housing costs was higher in Kāne‘ohe than elsewhere. The low proportion of households with more than 1.0 occupant per room suggests that crowding is less of a problem in Kāne‘ohe than elsewhere in Hawai‘i. Indicators of low income and the incidence of disabilities in the population are shown in the next two tables. The share of people with low incomes is smaller in Kāne‘ohe than in the state but the area houses a proportionate number of low-income and minority residents.

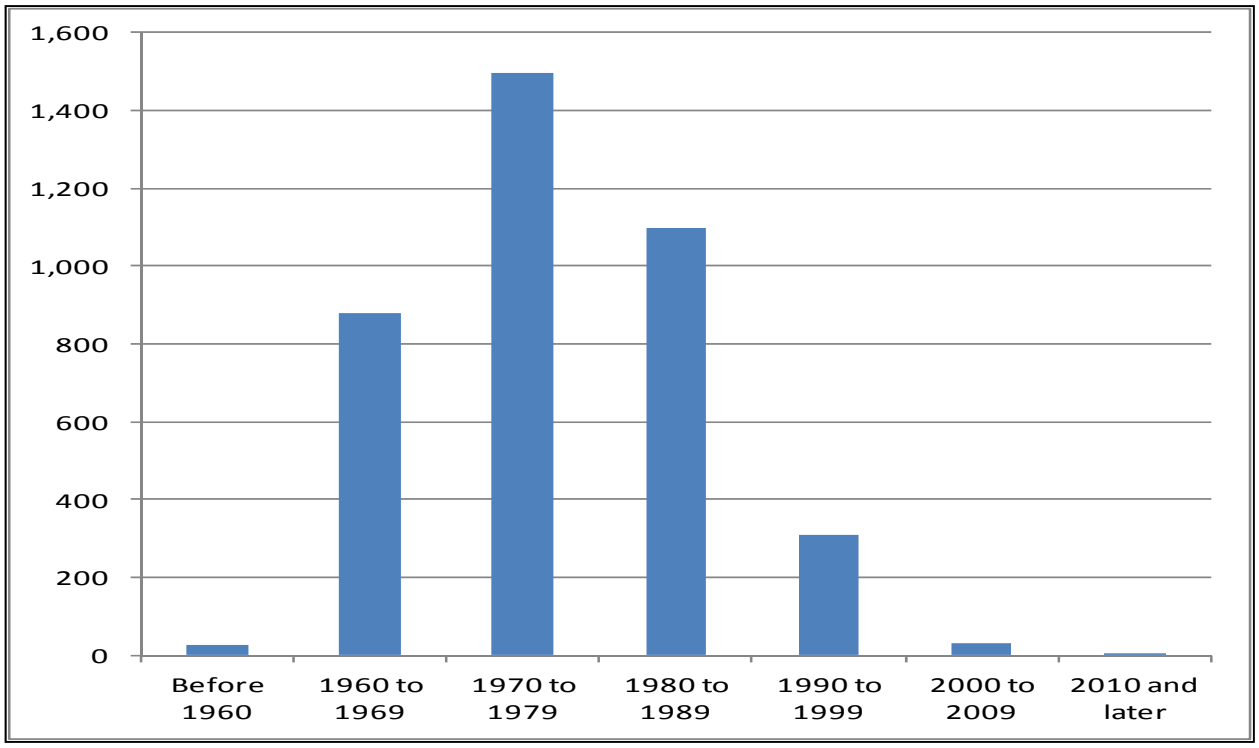

Figure 1.22. Homes in the He‘eia area (TMK 1-4-6), by year built

(Hawai‘i Information Service, Inc. 2015)

1.5.1.2 Economy

The Ko‘olaupoko region includes a major job center (Marine Corps Base Hawai‘i Kāne‘ohe Bay), a hospital (Castle Medical Center, in Kailua), and several shopping centers that offer retail jobs. Windward Mall is the largest retail center. Located at Kamehameha Highway and Ha‘ikū Road, it is just outside the immediate area of the He‘eia NERR. Table 1-6 compares economic characteristics for residents of the Kāne‘ohe ZCTA and the state as a whole.

Table 1-2. Demographic Characteristics, ACS, State of Hawai‘i and Kāne‘ohe ZCTA – 5-Year Profiles (American Community Survey 2013)

	State of Hawai‘i	Kāne‘ohe ZCTA 96744
Population	1,376,336	52,509
Total Population		
Under 5 years	89,223	3,218
5 to 9 years	81,708	2,998
10 to 14 years	83,842	2,954
15 to 19 years	83,355	3,002
65 to 74 years	107,791	4,927
75 to 84 years	63,137	3,160
85 years and over	32,991	1,309
Median age (years)	38.3	41.8
Race		
White	25.00%	21.60%
Black or African American	1.80%	0.80%
American Indian and Alaska Native	0.20%	0.30%
Asian	38.30%	36.20%
Native Hawaiian and Other Pacific Islander	9.80%	8.90%
Hispanic	9.30%	9.10%
Two or more races	23.80%	23.10%
Place of Birth		
Hawai‘i	54.50%	71.10%
Other state	24.70%	18.40%
US Island	2.90%	2.70%
Foreign born	17.90%	7.80%

ACS = American Community Survey; ZCTA = Zip Code Tabulation Area

Table 1-3. Household Characteristics, ACS, State of Hawai‘i and Kāne‘ohe ZCTA

Housing and Households	State of Hawai‘i	Kāne‘ohe ZCTA 96744
Total housing units	522,164	16,786
Occupied housing units	449,771	16,051
Vacant housing units	13.9%	4.4%
HOUSEHOLDS BY TYPE		
Total households	449,771	17,152
Households with one or more people under 18 years	33.7%	31.9%
Households with one or more people 65 years and over	30.7%	35.6%
Average household size	2.96	3.09
HOUSING TENURE		
Occupied housing units	449,771	16,051
Owner-occupied	57.6%	62.9%
Renter-occupied	42.4%	37.1%
Average household size of owner-occupied unit	3.11	3.13
Average household size of renter-occupied unit	2.77	2.87
OCCUPANTS PER ROOM		
Occupied housing units		
1.00 or less	91.2%	97.1%
1.01 to 1.50	5.7%	2.4%
1.51 or more	3.1%	0.4%
Share of households paying > 35% of income for housing (for households with rent or mortgage data)		
Owners	29.0%	29.5%
Renters	46.6%	59.6%

ACS = American Community Survey; ZCTA = Zip Code Tabulation Area

Table 1-4. Share of Persons below the Poverty Line, ACS, State of Hawai‘i and Kāne‘ohe ZCTA

	State of Hawai‘i	Kāne‘ohe ZCTA 96744
PERCENTAGE OF PEOPLE WHOSE INCOME IN THE PAST 12 MONTHS IS BELOW THE POVERTY LEVEL		
All people	11.2%	7.4%
Under 18 years	15.4%	10.4%
18 to 64 years	10.5%	7.3%
65 years and over	7.4%	4.2%

ACS = American Community Survey; ZCTA = Zip Code Tabulation Area

Table 1-5. Share of Persons with Disabilities, ACS, State of Hawai‘i and Kāne‘ohe ZCTA

	State of Hawai‘i	Kāne‘ohe ZCTA 96744
DISABILITY STATUS OF THE CIVILIAN NONINSTITUTIONALIZED POPULATION		
Total Civilian Noninstitutionalized Population	1,323,796	52,493
With a disability	10.8%	10.9%
Under 18 years	304,623	11,162
With a disability	3.0%	3.1%
18 to 64 years	819,961	32,238
With a disability	7.9%	7.2%
65 years and over	199,212	9,093
With a disability	34.9%	33.6%

ACS = American Community Survey; ZCTA = Zip Code Tabulation Area

In 2000, employers reported paying some 9,995 employees in the Kāne‘ohe ZCTA. By 2012, this figure had declined to 8,598.[5] The unemployment rate for Kāne‘ohe residents was low (Table 1-6). The share of the workforce employed in agriculture or fishing was even lower than statewide. The average household income for ZCTA 96744 residents was 127% of the state average (Table 1-6).

[5] These figures should be seen as a minimum of local civilian employment. They exclude government jobs. Firms with multiple sites may list employees as based at their headquarters, not other outlets. (U.S. Census 2015)

Table 1-6. Selected Economic Characteristics, ACS, State of Hawai‘i and Kāne‘ohe ZCTA

	State of Hawai‘i	Kāne‘ohe ZCTA 96744
EMPLOYMENT STATUS		
Population 16 years and over	1,104,534	43,953
In labor force	728,795	29,478
Civilian labor force	688,820	28,534
Percent Unemployed	7.1%	5.8%
COMMUTING TO WORK		
Workers 16 years and over	663,718	27,437
Car, truck, or van -- drove alone	66.6%	71.0%
Car, truck, or van -- carpooled	14.4%	16.2%
Public transportation (excluding taxicab)	6.4%	4.6%
Walked	4.7%	2.5%
Other means	3.5%	2.0%
Worked at home	4.5%	3.7%
Mean travel time to work (minutes)	26.0	28.9
INDUSTRY		
Civilian employed population 16 years and over	640,072	26,878
Agriculture, forestry, fishing and hunting, and mining	1.5%	0.6%
Construction	7.0%	9.2%
Manufacturing	3.1%	2.9%
Wholesale trade	2.4%	2.5%
Retail trade	11.8%	10.2%
Transportation and warehousing, and utilities	5.8%	6.9%
Information	1.6%	1.9%
Finance and insurance, and real estate and rental and leasing	6.5%	5.8%
Professional, scientific, and management, and administrative and waste management services	10.1%	9.9%
Educational services, and health care and social assistance	20.9%	25.0%
Arts, entertainment, and recreation, and accommodation and food services	16.2%	9.4%
Other services, except public administration	4.5%	5.1%
Public administration	8.6%	10.6%
Median household income (dollars)	$67,402	$85,608

ACS = American Community Survey; ZCTA = Zip Code Tabulation Area

1.5.1.3 Community Life

Kāneʻohe region residents are represented by Neighborhood Boards (No. 30 for Kāneʻohe, No. 29 for Kahaluʻu). Stakeholders in the bay are represented on the Kāneʻohe Bay Regional Council established by Hawaii Revised Statutes (HRS) 200D to facilitate the implementation and periodic review of the *Kāneʻohe Bay Master Plan*. Kāneʻohe has its own chamber of commerce and sports organizations.

Recreational activities in Kāneʻohe Bay include fishing, sailing, and snorkeling. The sand bar (Ahu o Laka, offshore from Puʻu Maʻeliʻeli) attracts large parties, and DLNR has found the need to enforce rules against unruly behavior and drinking alcohol on holiday weekends (DLNR 2014). The small boat harbor at Heʻeia Kea (just north of the Heʻeia NERR) is the base for many recreational activities in Kāneʻohe Bay. It has docking and mooring space for both commercial and recreational boats. Boaters may also use marinas at Kāneʻohe Yacht Club, Makani Kai, and the Marine base.

Kāneʻohe Bay has little sand and surf. Also on the windward side of Oʻahu, the nearby towns of Kailua and Waimānalo have extensive beach parks. These beach parks are very popular with Oʻahu residents and visitors for many types of ocean recreation.

1.5.1.4 Roads and Traffic Congestion

Kāneʻohe is served by two major routes across the Koʻolau Mountains: Likelike Highway and the H-3 Highway. These cross two major roadways, Kahekili Highway and Kamehameha Highway. The former is wide and serves as the road leading to the North Shore of Oahu. The latter links Kāneʻohe to Kailua to the south. In Kāneʻohe, the major retail centers all front Kamehameha Highway. In Heʻeia, the road narrows and continues along the coast until it joins Kahekili Highway in Kahaluʻu. (From Kahaluʻu northward, the merged route is identified as Kamehameha Highway) (See Figure 7-1).

Traffic volume data from 2013 for the intersection of Kamehameha Highway with Haʻikū and Lilipuna Roads (by Windward Mall) show that more traffic travels toward the center of Kāneʻohe versus north to Heʻeia (Table 1-7).

Table 1-7. Traffic Counts on Kamehameha Highway at Its Intersection with Haʻikū and Lilipuna Roads

Road	Number of Vehicles	
	Northbound on Kamehameha Highway	Southbound on Kamehameha Highway
Kamehameha Highway	2,665	6,740[a]
Haʻikū Road	1,031	6,707
Lilipuna Road	1,808[a]	1,033

Source: City and County of Honolulu 2013.

Notes: Traffic counts from October 2013.

Figures include traffic moving to Haʻikū Road as well as the highway.

1.5.2 The Heʻeia NERR and Its Environs

1.5.2.1 Population

The *environs*[6] of the Heʻeia NERR had some 869 residents in 2010, representing 1.6% of the Kāneʻohe ZCTA population at the time. The environs support scattered residential properties among densely vegetated areas. Many residents have been in the area for multiple generations. Heʻeia Elementary School's description of its community underscores this point:

> We draw from an area where the sense of family and community is strong. Grandchildren and children of former Heʻeia students attend the school. Alumnae have returned to work at the school. Most staff lives in Kāneʻohe or on the Windward side. Our facilities are heavily used by youth sports and community organizations. (Heʻeia Elementary School 2015)

The school reports its student population as 45% Native Hawaiian, 16% Caucasian, and 12% Japanese.

1.5.2.2 Economy

Within the Heʻeia NERR, HIMB is the largest employer with some 19 scientists, about 20 other staff members, and graduate students, volunteers, and visiting researchers. Nonprofits in the area have a small workforce (staff and volunteers, less than 10 each) and call on others for support on community workdays.

[6] The environs are identified here as Census Tract 105.05, blocks 1007 (250 persons in land beside Heʻeia Fishpond and Ipuka Street) and 1008 (585 persons in the Heʻeia wetlands area and areas to the south to Haʻikū Road along Kamehameha Highway), and Census Tract 103.06, block 3001 (34 persons, land makai (seaward) of the highway, including the state park and an area to the north).

1.5.2.3 Community Life

The organizations currently active in He‘eia NERR involve the wider community and are engaged in ongoing efforts to restore the He‘eia ecosystem.

- Kāko‘o ‘Ōiwi—Hawai‘i non-profit organization restoring He‘eia wetlands under a 38-year lease from HCDA
- Paepae o He‘eia—Hawai‘i non-profit organization restoring and maintaining the fishpond under lease from Kamehameha Schools.
- Programs at He‘eia State Park:
  - Kama‘āina Kids programs.
  - Rental of facilities for family events and other group activities.
- HIMB—community involvement with HIMB includes educational visits, volunteer activities, and informal collaboration with other windward O‘ahu programs, including the Kāko‘o ‘Ōiwi and Paepae o He‘eia restoration efforts.
- Several organizations are involved in oversight and support of the nonprofit groups in the He‘eia NERR, notably:
  - Ko‘olaupoko Hawaiian Civic Club (KHCC): This club has encouraged restoration of the wetland by Kāko‘o ‘Ōiwi. Many of its senior members were involved in past efforts to stop urbanization of He‘eia.
  - Hawai‘i Community Development Authority (HCDA): The HCDA obtained ownership of the He‘eia Wetland in 1991 in a land exchange agreement. The He‘eia Community Development District (CDD) was established by the State Legislature in 2011. The He‘eia CDD is governed by the Hawai‘i Community Development Authority board, of which 3 members are representatives from the He‘eia CDD. Kāko‘o ‘Ōiwi, a Hawaii non-profit corporation, currently has a 38 year lease with the HCDA that was executed in 2010. The He‘eia CDD was established to facilitate cultural practices, culturally appropriate agriculture, education and natural resource restoration and management of the He‘eia wetlands.
  - The Nature Conservancy (TNC): The Hawai‘i office of this national nonprofit supports the efforts of Kāko‘o ‘Ōiwi with staff and volunteer contributions.
  - Kamehameha Schools: The estate of Princess Bernice Pauahi Bishop, dedicated to educational activities, has come to assess its Hawai‘i landholdings in terms of ecological and cultural values, as well as economic support for the Schools’ educational activities. Kamehameha Schools owns the He‘eia Fishpond.
  - DLNR: DLNR has set fishing regulations for the marine area of the He‘eia NERR. It runs the small boat harbor at He‘eia Kea, where the harbormaster has limited oversight over recreational

boaters and commercial operators. Its enforcement arm, the Division of Conservation and Resource Enforcement, can enforce fishing and other environmental regulations. The Division of State Parks manages and administers He'eia State Park. The Divison of Aquatic Resources manages and regulates state marine and freshwater resources, as well as issues fishing licenses.

1.6 Ecosystem-Based Services at the He'eia NERR

Ecosystem-based management (EBM) is a long-term, integrated management approach that recognizes humans are a necessary part of and have significant influences on their environments. EBM embodies a fundamental shift away from ineffective conventional management paradigms that are frequently short term, reactionary, suffer jurisdictional limitations, and consider humans to be independent of nature and inconsistent with conservation goals (McLeod & Leslie 2009). As such, EBM advocates argue for a new holistic, resilience-based approach to ocean and coastal management, which has been heralded as "a critical new course for marine management" (*Science* 2009).

The question remains how best to implement this strategy, and what exactly constitutes EBM as an explicit adaptive management strategy to maximize resilience and sustainability of ecosystem services desired by all stakeholders. The basic premises of EBM are to: 1) prioritize the health and function of the entire ecosystem over the needs of any individual activity or special interest group; 2) be place-based with natural boundaries; 3) account for multiple interactions, and how human actions both within and outside the place can influence or be influenced by management; 4) integrate the concerns of the environment, society, economy and human institutions; 5) consider humans as part of the system and maintain access to cultural ecosystem services demanded by people; and 6) provide a mechanism for coordination among all responsible entities (McLeod & Leslie 2009). Despite widespread consensus on the general tenets of EBM, the specifics of the approach, and the ability to implement EBM, remain a considerable challenge (Levin & Möllmann 2015; Prellezo & Curtin 2015). Table 1-8 outlines examples of ecosystem service metrics that can be measured in the different habitat areas of the He'eia NERR and against which the effects of management strategies will be measured.

Table 1-8. Examples of Ecosystem Service Metrics

Terrestrial Upland Habitat:
● Soil & nutrient retention
● Species biodiversity
● Native Species recovery (wildlife habitat)
● Cultural traditions
● Clean groundwater

● Stable Hydrology & groundwater recharge ● Economic Security ● Food Security
Estuarine Habitat:
● Soil and nutrient retention ● Sustainable fishery stocks ● Native Species recovery (wildlife habitat) ● Cultural traditions ● Recreational Opportunities ● Food security ● Flood protection ● Shoreline stabilization
Marine Habitat:
● Sustainable fishery stocks ● Species biodiversity ● Native Species recovery (wildlife habitat) ● Cultural traditions ● Recreational Opportunities ● Healthy coral reefs ● Tsunami & storm protection ● Food SecurityThreats and Stressors

1.7 Threats and Stressors

1.7.1 Natural and Anthropogenic Stressors

Kāneʻohe Bay is the largest sheltered body of water in the Hawaiian Islands. The semienclosed nature of the bay makes the Heʻeia estuary more vulnerable than an open coastline to damage by factors associated with urbanization and other human activities (Jokiel 1991). Typical of Hawaiian watersheds located on

small landmasses, the spatial extent of the He‘eia watershed is limited and there are tight links between terrestrial ecosystems and coastal environments directly downstream. Natural and anthropogenic stressors for He‘eia NERR include invasive species, soil erosion, sedimentation, nonpoint source pollution, and ocean recreational activities.

The estuarine ecosystem of He‘eia continues to be threatened by the invasion of non-native mangroves. Extensive efforts have been made to remove mangroves from the fishpond walls but, dense mangrove stands still occupy the upper intertidal areas of the He‘eia NERR, the seaward portion of the fishpond, the lower reaches of the He‘eia Stream, and the mudflats. The mangroves alter stream flow, trap nutrients and sediments from the He‘eia Stream, and confine the intrusion of saltwater upstream. Deposition of nutrients overtime and altered rates of freshwater discharge have significantly reduced the estuarine environment over time. The expansion of mangroves has also reduced the open marshlands once used by native waterbirds.

The He‘eia stream and the associated wetlands also continue to be threatened by invasive California grass that impedes water flow and quality. The stream does not allow for fish passage and therefore is a poor habitat for native fish. Degradation resulting from the introduction of nonnative animals which prey on and displace native species and alter habitat is also a threat to native and indigenous freshwater and estuarine fish and invertebrate species and their habitats (Bishop Museum 2010, Townscape 2010). The forested upland habitats as discussed above (Section 1.3.1.1) are also dominated by non-native vegetation.

Threats to marine resources include displacement of fauna by the introduction and spread of invasive species, pollution, disease, and ocean recreational activities. The coral reefs in He‘eia NERR are currently being restored by removing invasive algae with a mechanical device called the “Super Sucker” (DAR 2013). However, the marine resources are constantly under threat of degradation from sedimentation, diseases, dredging, or the introduction of new invasive species because of the use of the marine waters for research and private and commercial recreational purposes such as fishing, water skiing and sledding, jet skiing, and boat tour operations.

Large scale commercial or residential development is not planned in or near the vicinity of the He‘eia NERR. However, because of the existing high density of residential homes and the large amount of impervious surfaces in close proximity to the stream, fishpond, and Kāne‘ohe Bay, the waters of the He‘eia watershed are highly vulnerable to nonpoint source pollution including runoff.

1.7.2 Climate Change Impacts

As climate modeling and downscaling capabilities improve, projections for future climate change can be made with increased confidence. Although climate change impact projections for Kāne‘ohe Bay and the He‘eia region are not available, the following are climate change regional highlights for Hawai‘i and the

Pacific Islands observed over the twentieth century or are projected to occur at some time during or by the end of the twenty-first century. These results have been excerpted from *Global Climate Change Impacts in the United States* (GCRP 2009), the state of knowledge report issued by the U.S. Global Change Research Program.

- Warmer oceans are leading to increased coral bleaching events and disease outbreaks in coral reefs, as well as changed distribution patterns of tuna fisheries. Ocean acidification will reduce coral growth and health. Warming and acidification, combined with existing stresses, will strongly affect coral reef fish communities.
- Freshwater supplies are already constrained and will become more limited on many islands. Saltwater intrusion associated with sea level rise will reduce the quantity and quality of fresh water in coastal aquifers, especially on low islands. In areas where precipitation does not increase, freshwater supplies will be adversely affected as air temperature rises.
- Increasing temperatures, and in some areas reduced rainfall, will stress native Pacific Island plants and animals, especially in high-elevation ecosystems with increasing exposure to invasive species, increasing the risk of extinctions.
- Rising sea levels, coupled with high water levels caused by storms, will incrementally increase coastal flooding and erosion, damaging coastal ecosystems, infrastructure, and agriculture, and negatively affecting tourism.
- Mounting threats to food and water security, infrastructure, health, and safety are expected to lead to increasing human migration, making it increasingly difficult for Pacific Islanders to sustain the region's many unique customs, beliefs, and languages.

1.7.3 Reserve Sensitivity[7] and Vulnerability[8] to Climate Change

The *Climate Sensitivity of the National Estuarine Research Reserve System* (NOAA 2013) report examines some of the factors that make estuaries and the communities dependent on estuarine resources susceptible to climate change.

The report discusses how some estuaries may be much more vulnerable than others to the impacts of climate change. Scientists still do not fully understand which estuaries may be at greater risk or what the factors are which make some estuaries more susceptible to climate change than others. However, combining climate

[7] Sensitivity is a measure of whether and how a reserve or group of reserves is likely to be affected by both climate and non-climate stressors (NOAA 2013).
[8] Vulnerability is the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. There are three components to vulnerability as the term is used in this report: sensitivity, resilience, and exposure (NOAA 2013).

change information across disciplines (e.g. social and biophysical) provided a much more holistic view than would have been offered by any one of these areas by itself.

The following key features of NOAA's (2013) study could better inform the future research on the sensitivity and vulnerability of He'eia NERR.

- All reserves will be impacted by climate change at some level, with all reserves having one or more indices rated as high (or very high).

- Social sensitivity is of particular concern along the West Coast and at isolated reserves in the Caribbean, Great Lakes, and Gulf of Mexico.

- Biophysical sensitivity is of highest relative concern at isolated reserves in the Southeast and on the West Coast. The relevance of biophysical sensitivities at each reserve will also be determined by the natural resource management objectives of that reserve.

- Sea level rise will be a concern across all regions, with slightly less impact predicted for the Northeast than for other regions.

- Temperature change exposure will be a concern over most regions, with the largest effects in the Great Lakes, Northeast and Mid-Atlantic.

- The climate change indicators do not all co-vary. This means that reserves will have to consider different climate change stressors in their climate change vulnerability assessments and plan management strategies accordingly.

- Comparison of indicators reveals several reserves with notable climate change sensitivity. In relative terms, the Tijuana River Reserve has the highest risk for climate change impacts when looking across all five indices. Waquoit Bay Reserve is also at high risk.

- A better understanding of climate change vulnerability at the individual reserve level will require reserve-specific analyses.

Some salient points related to integrated approaches that were learned through NOAA's study on reserve sensitivity and vulnerability and that could be applied at He'eia NERR include:

- Defining an approach, strategy, or research effort as integrated at the onset helps define expectations and roles, which leads to more coherent and collaborative integration.

- Integrated approaches need to include time for interdisciplinary learning. The language, methods, and concepts of disciplines are often different and, as a result, integrated projects create learning opportunities and enhance perspectives for all involved.

- Integration of data across disciplines can prove quite challenging; however, even when quantitative integration of data is not possible, qualitative integration can produce valuable results and important insights.

Section 2. Community Engagement Process

There was an extensive community engagement process that laid the foundation for the nomination and designation of the He‘eia NERR. The general public and in particular the site partners, along with OP and NOAA, were fully engaged throughout the development of the He‘eia NERR management plan.

2.1 Basis for Community Engagement

The foundation for community engagement was laid by the Ko‘olaupoko Hawaiian Civic Club (KHCC), which actively engaged not only the Hawaiian community but the larger community in activities involving Kāne‘ohe Bay and the upland areas. The KHCC represents the ahupua‘a of Kāne‘ohe, He‘eia, Kahalu‘u, Waihe‘e, Ka‘alaea, Waiāhole, Waikāne, Hakipu‘u, and Kualoa on the windward side on the island of O‘ahu. Included in that representation are families and kūpuna who have lineal and cultural connections to He‘eia. In addition to the KHCC’s work, for more than 10 years, HIMB has been working to involve the community in its research projects in Kāne‘ohe Bay (PBR Hawai‘i 2014). Community engagement has included education programs and tours of Moku o Lo‘e for individuals, families, and community and school groups. Other groups, like Paepae o He‘eia and Kako‘o ‘Ōiwi, have long been actively engaged in culturally restoring the He‘eia Fishpond and the lo‘i kalo, respectively, and have generated great interest and involvement by the larger community in these efforts.

2.2 Cultural Principles

The following principles were integrated into the community engagement process that informed the development of the management plan. These principles, while common to most cultures, are especially important in a Hawaiian context:

- Respect or mahalo: An essential principle in developing the management plan was the importance of asking permission before acting, and being grateful for the opportunity to discuss issues.
- Humility or ha‘aha‘a: Listening with attention, respect, and compassion was also critical.
- Thoughtfulness or no‘ono‘o: The management plan was developed thoughtfully and attempts to reflect the spirit and interests of the community.
- Propriety or pono: The management plan is guided by the principle of doing what is right.
- Responsibility or kuleana: The success of the management plan is dependent on everyone taking responsibility for being prepared for meetings, for their stewardship of resources, and for caring for each other.

2.3 Community and Government Partnerships

The site partners who have played a vital role in the designation of He‘eia as a NERR site are described below:

- Ko‘olaupoko Hawaiian Civic Club (KHCC): This group was first established in August 1937 by a group of kama‘āina residents from Kāne‘ohe. KHCC is a nonprofit civic and community organization dedicated to the perpetuation and preservation of native Hawaiian history, culture, and heritage (KHCC 2015).

- Ko‘olau Foundation: The Ko‘olau Foundation is a cultural heritage preservation program with a mission to promote Hawaiian cultural and environmental practices, preservation, and education. (KHCC 2015).

- Paepae o He‘eia: This is a private, nonprofit organization dedicated to caring for the He‘eia Fishpond. Established in 2001 by a group of young Hawaiians, Paepae o He‘eia works in partnership with the landowner Kamehameha Schools to manage and maintain He‘eia Fishpond for the community. Paepae o He‘eia was established to mālama (care for) He‘eia Fishpond and serve as kia‘i (guardian) to this precious resource and treasure (Paepae o He‘eia 2015).

- Kāko‘o ‘Ōiwi: As stated on its website, “Kāko‘o ‘Ōiwi is a community-based non-profit organization based in the ahupua‘a of He‘eia, moku of Ko‘olaupoko, island of O‘ahu. With the support of the local community, Kāko‘o ‘Ōiwi acquired a 38-year lease agreement with the State of Hawai‘i Community Development Authority (HCDA) to implement Māhuahua ‘Ai o Hoi (Re-growing the fruit of Hoi), a long-range project to restore agricultural and ecological productivity to nearly 405 acres within the wetlands of

He‘eia. Through their cultural, educational and ecosystem restoration programs, Kāko‘o ‘Ōiwi is promoting the social and economic advancement of the local community.” (Kāko‘o ‘Ōiwi 2015).

- Hawai‘i Institute of Marine Biology (HIMB): The mission of HIMB is to conduct multidisciplinary research and education in all aspects of tropical marine biology. HIMB continues to be a world leader in research to understand and conserve tropical marine ecosystems. HIMB develops and implements new technologies that advance the informed stewardship of Hawai‘i’s marine and coastal biodiversity. (HIMB 2015).

- Kama‘āina Kids: A private, nonprofit, multiservice organization dedicated to serving children and their families through quality childcare programs (Kama‘āina Kids 2015a). The organization’s services include preschool programs, before and after school programs, environmental education programs, and enrichment programs, many of which are offered at He‘eia State Park.

The two government agencies that have played an instrumental role in the designation of the He‘eia NERR are the following:

- State of Hawai‘i Office of Planning: The Office of Planning (OP) is administratively attached to the Department of Business, Economic Development and Tourism (DBEDT) and provides technical assistance and coordination among different agencies and levels of government to assist in the overall analysis and formulation of state policies and strategies to guide the future development of the state.

- National Oceanic and Atmospheric Administration (NOAA): NOAA was established in 1807. The agency’s scope of responsibilities encompasses weather forecasting, issuing severe storm warnings, monitoring climate, managing fisheries, restoring coasts, and supporting marine commerce. NOAA works to protect life and property and conserve and protect natural resources.

This group of site partners continued to work together as the He‘eia NERR Steering Committee to provide input on the development of the management plan and provide logistical and administrative support for the site designation process. The role of the Reserve Advisory Board (RAB) after designation is explained in Section 5.5.1.

2.4 Community Engagement Process and Methods

A deliberate attempt was made by OP to initiate a broad-based engagement process that would inform, listen to, and solicit as much input as possible that included the following:

Public Meetings On January 9, 2014 and February 27, 2014, public meetings were held in Kāneʻohe to take comments on the selection of Heʻeia as the preferred site for a NERR in Hawaiʻi. Public notices about the public meetings were published in Honolulu's leading newspaper, the Star Advertiser and NOAA published in the Federal Register the *Public Meeting on the Proposed Heeia Site for a National Estuarine Research Reserve in Hawaii* on January 28, 2014 (Appendix C). Appendix C provides attendance sheets and a full list of comments collected on the selection of Heʻeia as the preferred site for a NERR in Hawaiʻi.

Public Scoping Meetings On November 24, 2014 NOAA published in the Federal Register the *Intent to Prepare a Draft Environmental Impact Statement for the Proposed Heʻeia National Estuarine Research Reserve in Kāneʻohe Bay, Hawaiʻi* (Appendix C). A public notice about the scoping meetings was also published in Honolulu's leading newspaper, the Star Advertiser (Appendix C). The public notice invited interested parties to attend the two public meetings held on December 17, 2014 in Kāneʻohe, Hawaiʻi and on December 19, 2014 in Honolulu, Hawaiʻi, as well as to provide comments on the scope of the significant issues to be analyzed in the draft environmental impact statement (EIS) and the draft management plan. Appendix C provides public meeting agenda, attendance sheets and meeting notes.

- **First Series of Focus Group Meetings** In addition to the public scoping meetings, OP convened three focus groups on (1) Education, Training, and Interpretation; (2) Research and Monitoring; and (3) Public Outreach and Resource Management. These meetings engaged the community in a more targeted discussion of the strategic vision, mission, goals, objectives, and strategies for the Heʻeia NERR. The purpose of the focus group meetings was to gather input from the community on the Strategic Plan for the Heʻeia NERR management plan. Refer to Appendices D, E, and F for copies of the meeting agendas, meeting notes, and attendance sheets.

- **Second Series of Focus Group Meetings** To ensure that the Strategic Plan accurately reflected the community's mana'o (thoughts), a second series of focus group meetings was conducted to present a working draft of the He'eia NERR strategic vision, mission, goals, objectives and strategies to the community stakeholders. Appendix G includes the meeting agendas, meeting notes, and attendance sheets.
- **Steering Committee Meetings** After listening to the comments of the focus groups, OP revised the Strategic Plan to integrate the NERRS strategic plan guidelines and the unique values and activities in He'eia. Appendix H includes the Steering Committee meeting agenda.
- **KHCC Membership Meeting** Responding to a request by the KHCC, a presentation of the He'eia NERR designation process was given to its members.
- **Kāne'ohe Bay Regional Council Meeting** In order to update the Council regarding the He'eia NERR designation process, presentations were given to the Council.
- **Kahalu'u Neighborhood Board Meeting** Responding to a request by the Kahalu'u Neighborhood Board, a presentation of the He'eia NERR designation process was given to its members.
- **Website Outreach** OP regularly updates its website with project news, notices, and frequently asked questions (FAQs). Appendix I gives a summary of the FAQs and answers that have been posted on the OP website.

Section 3. Reserve Strategic Plan

The He‘eia NERR Strategic Plan provides a framework and direction for the He‘eia NERR over the next five years. The He‘eia NERR has several active site partners who have their own strategic plans (HIMB, Paepae o He‘eia, Kako‘o ‘Ōiwi, and KHCC) who are actively implementing those plans. While each site partner may have their own strategic plan, they all share a similar vision of honoring the past (traditional knowledge) and utilizing contemporary science and resources to restore a healthy resilient human and natural community within the ahupua‘a of He‘eia. It was this shared vision that brought them together to seek resources and a management structure that would have the ability to reach beyond their own geographic boundaries to develop a plan that integrated their activities into a cohesive plan. For the site partners, the He‘eia NERR provides that opportunity to effectively and efficiently collaborate and coordinate their respective activities to meet not only the goals and objectives of the He‘eia NERR but their own respective strategic plans as well.

It was apparent during the strategic planning process that a consistent theme was the importance of getting baseline data, inventorying the research that has already occurred within the area to avoid duplication and identify gaps in the research. Site partners all want to get a better understanding of each others’ activities. There is a need to determine the impacts on the ecosystem of the various restoration and manipulation activities occurring within the He‘eia NERR.

Thus, the He‘eia NERR Strategic Plan for the first five years is focused primarily on baseline information, monitoring, research, education, stewardship, and community engagement. Accordingly, the adaptive management approach of promoting a flexible plan that may be adjusted as information becomes available is especially well-suited for this early stage of the He‘eia NERR. Moreover, this approach is in alignment with the State’s CZM Priorities as well as NOAA’s priorities. This is a thoughtful and responsible course of action: to proceed with the implementation of the He‘eia NERR Strategic Plan with a focus on coordinated research and monitoring, education and stewardship, resource management, and financial prudence rather than initiating redundant and unaligned programs. There is support for the idea that as information becomes available, the management plan will be reassessed and adjusted accordingly.

3.1 Vision and Mission

A clear vision and mission, and guiding principles, create an essential foundation to a management plan. During Phase I of the NERR site selection process, the long-term benefits of establishing a NERR in Hawai‘i were recognized. During Phase II, the best site to provide those benefits was selected and incorporated into the nomination document. During Phase III, the focus groups, with input from the steering committee, developed the He‘eia NERR vision and mission as follows.

He‘eia NERR Vision

Ho‘ōla: The biological and cultural integrity of the ahupua‘a of He‘eia is restored to create an ‘āina momona (abundant) legacy for future generations. The ahupua‘a of He‘eia is a global example of thriving and resilient socioecological communities.

He‘eia NERR Mission

Kuleana (privilege and responsibility): To practice and promote responsible stewardship and outreach consistent through the principles and values of the ahupua‘a land management system. Our efforts will be supported by traditional knowledge, innovative research, education, and training that nourishes healthy and resilient ecosystems, economies, and communities.

This vision is a place-based, He‘eia-specific version of the national system’s vision: “Resilient estuaries and coastal watersheds where humans and nautral communities thrive.” The He‘eia NERR mission is a place-based version of the national system’s mission: “To practice and promote stewardship of coasts and estuaries through innovative research, education, and training using a place-based system of protected areas.”

The He‘eia NERR’s primary research question frames the research goals and associated manipulation and restoration activities being undertaken at the site. The research goals are discussed in Section 4.1, manipulation activities in Section 10, and restoration activities in Section 11.

He‘eia NERR Primary Research Question

By measuring the suite of ecosystem services provided by two management strategies of contemporary ecological restoration and one that embraces traditional Native Hawaiian management practices, the He‘eia NERR intends to evaluate these approaches within the He‘eia NERR boundaries to create an integrated approach that makes the He‘eia NERR a model for EBM strategies for Pacific Island estuarine ecosystems.

3.2 Priority Coastal Management Issues

There are a number of priority coastal management issues for the He‘eia NERR. These issues include a number of natural processes and anthropogenic effects: invasive species, loss of habitat, erosion and sedimentation, nonpoint source pollution, urbanization and human activities in the area, water quality issues, agricultural development, and climate change impacts on the area. Invasive species, including algae and certain fish species in Kāne‘ohe Bay and mangrove, grass and other species on land, are crowding out native species. The loss of habitat for native species is a concern for many groups at the He‘eia NERR. Erosion and sedimentation affect He‘eia Stream, He‘eia Fishpond, and water further out into Kāne‘ohe Bay, choking fish and coral. Nonpoint source pollution from nearby urban and residential areas and its effects on water quality are also of great concern. Agricultural development is an important activity in the area which will have far-reaching impacts on the land and receiving waters, not to mention the species that inhabit the area. Finally, climate changes including drought, increased flooding, salt water intrusion or seal level rise, may affect the area, including the species the ecosystem supports. Understanding these issues and the effects these processes have on the ecosystem is a high priority for the He‘eia NERR.

These coastal management issues that are a high priority in He‘eia are also relevant to state and federal coastal priorities. In 2010, the National Ocean Council and the National Ocean Policy (NOP) were established by the President’s Executive Order 12547 as part of the Final Recommendations of the Interagency Ocean Policy Task Force (2010). National Priority Objectives (NPO) under the NOP were also established. In 2013, the State of Hawai‘i Office of Planning, CZM Program (OP-CZM) updated the Hawai‘i ORMP[9] and identified three perspectives which were consistent with the NPO. The He‘eia NERR

[9] The Vision statement adopted under the ORMP is as follows, “The vision for Hawai‘i’s ocean resources is a healthy, productive, and sustainable ocean ecosystem that fosters economic growth while preserving and protecting Hawai‘i’s values and needs.” The ORMP vision statement and the He‘eia NERR vision are consistent and in alignment.

priority coastal management issues and corresponding goals align with both the Federal NPO and the State ORMP, as illustrated in Table 3-1.

Table 3-1. National Objective, State Perspective and Local Goals and Priority Issues

NPO Objective	ORMP Perspective	He‘eia NERR Goal	He‘eia NERR Priority Issues
Ecosystem-Based Management Regional ecosystem protection and restoration	1. **Connecting Land and Sea:** ORMP adopts place-based management as a foundational principal, which applies to nearshore fisheries, coral reefs, sea grasses, and other resources. This goal addresses soil erosion and pollutant loads.	1. Increase our understanding of the effects of human activities and natural events to **improve informed decision making** affecting the He‘eia estuary, coastal ecosystems, and ultimately the entire ahupua‘a of He‘eia.	Invasive species, loss of habitat, water quality issues
Water quality and sustainable practices on land	2. **Preserving Our Ocean Heritage:** ORMP recognizes marine resources, coral reefs, the ocean economy, and the cultural heritage of the ocean as ways to promote a sustainable Hawai‘i.	2. Develop a place-based education and training program for the He‘eia NERR that **inspires and educates the community about estuaries, coastal ecosystems, and traditional Hawaiian practices**, such as lo‘i and loko i‘a, that mālama (nurture) these systems sustainably.	Water quality issues, erosion and sedimentation, nonpoint source pollution, urbanization and human activities in the area, agricultural development
Inform Decisions and Improve Understanding Coordinate and Support Resiliency and	3. **Promoting Collaboration and Stewardship:** ORMP aims to build capacity for community participation in resource management through education and	3. The He‘eia NERR will engage various communities to create opportunities for collaboration to practice and promote stewardship	Agricultural development, climate change

Adaptation to Climate Change and Ocean Acidification	outreach. Climate change adaptation is included.	that **sustains cultural, biological, and natural resources**.	

3.3 Goals and Objectives

The He‘eia NERR management plan has been organized with goals and objectives that are based on an adaptive management planning framework. The management plan includes tasks to coordinate activities and apply new and traditional knowledge learned and shared to manage the He‘eia NERR. The goals identified below are the long-term intentions of the He‘eia NERR and can be applied beyond the 5-year timeframe of this management plan. These goals, focusing on the He‘eia estuary, traditional knowledge, coastal resources, and issues, closely link to the NERRS program sectors of education, research and training, and stewardship. The listed objectives under each goal are statements that describe what the He‘eia NERR is intended to accomplish within the first 5 years.

In order to reach the goals of the He‘eia NERR, the primary research question (See third box under Section 3.1) frames the different ecosystem-based management strategies that will be implemented on the site. The strategies influence a broad array of services that contribute to a healthy and sustainable estuarine ecosystem in the face of ongoing anthropogenic impacts, and human use demands. The He‘eia NERR plans to examine the ecosystem services provided by two management strategies: (1) an approach based on contemporary ecological restoration techniques to increase native species biodiversity, ecological resilience, and ecosystem integrity; and (2) an approach that embraces traditional Native Hawaiian management practices to return the ecosystem to a state that was realized within the traditional ahupua‘a system. Both strategies seek to integrate the concerns of the environment, society, economy, and human institutions, but focus on different aspects of each.

3.3.1 Research and Monitoring

Goal 1

Increase our understanding of the effects of human activities and natural events to **improve informed decision making** affecting the He‘eia estuary, coastal ecosystems, and ultimately the entire ahupua‘a of He‘eia.

Objectives

1. Baseline environmental data informs researchers' understanding of the magnitude of changes in the various He‘eia ecosystems.
2. Coordinate independent research and monitoring efforts in the ahupua‘a.
3. Integrate traditional knowledge and research in the He‘eia NERR that will better reflect and inform community decision making toward creating a sustainable ecosystem.

3.3.2 Education

> **Goal 2**
>
> Develop a place-based education and training program for the He‘eia NERR that **inspires and educates the community about estuaries, coastal ecosystems, and traditional Hawaiian practices**, such as lo‘i and loko i‘a, that mālama (nurture) these systems sustainably.

Objectives

4. Increase student, educator, and community understanding of estuaries in general and in particular Hawaiian estuaries, coastal habitats, and the ahupua‘a land management system.
5. Provide a comprehensive framework to integrate and enhance coordination and effectiveness of place-based education and training programs that have been initiated independently by the He‘eia community.

3.3.3 Stewardship

> **Goal 3**
>
> The He‘eia NERR will engage various communities to create opportunities for collaboration to practice and promote stewardship that **sustains cultural, biological, and natural resources**.

Objectives

6. Integrate traditional knowledge and contemporary science to effectively address climate change, habitat restoration, and water quality.

7. Engage and educate the community on the practices and values of the ahupua‘a land management system; in other words, promote ‘āina momona and enhanced stewardship efforts by all sectors of the community, to increase their understanding of how human activities and natural events affect the estuary.
8. Become a leading repository of information for cultural, biological, and natural resources in the He‘eia estuary.
9. Develop the tools, capacity and connections to increase public awareness across the community, island, state, nation, and the world of the ecological and cultural significance of the He‘eia estuary and ultimately the entire ahupua‘a of He‘eia.
10. Support restoration of key areas in the He‘eia NERR to improve habitat and increase ecosystem services.

3.4 Strategies

For each of the above objectives, this management plan sets forth strategies to provide guidance on clear actions that could be taken to fulfill the goals and objectives. Each strategy is linked to a proposed outcome that can be used to measure progress or success in accomplishing the strategy and, subsequently, the corresponding objective and goal. These strategies and proposed outcomes are discussed in Section 4, “Reserve System Program Foundations.”

Section 4. Reserve System Program Foundations

4.1 Research and Monitoring Program

4.1.1 NERRS Research and Monitoring Program

The NERRS's mission provides that reserves are protected and managed to afford opportunities for long-term research. Research at each reserve is designed to fulfill the Reserve System goals as defined in the regulations (15 CFR 921[b]):

- Address coastal management issues identified as significant through coordinated estuarine research within the system.
- Promote federal, state, public and private use of one or more reserves within the system when such entities conduct estuarine research.
- Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.

To sustain these system goals, the *2011–2016 Reserve System Strategic Plan* outlines research objectives that support the focus areas of climate change, habitat protection, and water quality:

- Expand capacity to monitor changes in water quality and quantity, habitat, and biological indicators in response to land use and climate change drivers.
- Improve understanding of the effects of climate change and coastal pollution on estuarine and coastal ecology, ecosystem processes, and habitat function.
- Characterize coastal watersheds and estuary ecosystems and quantify ecosystem services to support ecosystem-based management of natural and built communities.
- Increase social science research and use of social information to foster coastal stewards that value and protect estuaries.

The reserve system's research and monitoring programs provide the scientific basis for addressing coastal management challenges. Reserve research and monitoring activities provide valuable information about estuarine resources to increase understanding and awareness of their importance to a variety of audiences including scientists, resource managers, educators, and the general public.

4.1.1.1 Reserve System Research Programs

Currently, there is one focused effort to fund estuarine research in the reserve system. The National Estuarine Research Reserve System Science Collaborative (Science Collaborative) is a program that focuses on integrating science into the management of coastal natural resources. Through an adaptively managed program, the Science Collaborative funds collaborative research and science transfer programs and projects that develop and apply science-based tools to better understand how to detect, prevent, and reverse the impacts of coastal pollution, habitat degradation and ecosystem processes in a time of climate change. The program is designed to enhance the Reserve System's ability to support decisions related to coastal resources through collaborative approaches that engages the people who produce science and technology with those who need it. In so doing, the Science Collaborative seeks to make the process of linking science to coastal management decisions, practices, and policies more efficient, timely, and effective and share best practices and examples for how this can be done.

4.1.1.2 Reserve System-Wide Monitoring Program

The SWMP provides standardized data on national estuarine environmental trends while allowing the flexibility to assess coastal management issues of regional or local concern and is guided by the Reserve SWMP Plan. The principal mission of the monitoring program is to develop quantitative measurements of short-term variability and long-term changes in water quality, biological systems, and land use/land cover characteristics of estuaries and estuarine ecosystems for the purposes of informing effective coastal zone management. The program is designed to enhance the value and vision of the reserves as a system of national references sites and focuses on three ecosystem characteristics:

1. **Abiotic Characteristics:** Abiotic measurements are supported by standard protocols, parameters, and approaches that describe the physical environment including weather, water quality, hydrological, and sediment related parameters. The monitoring program currently provides data on water temperature, specific conductivity, percent saturation of dissolved oxygen, pressure, pH, turbidity, salinity, concentration of dissolved oxygen, and pressure corrected water depth. Meteorological data include air temperature, relative humidity, barometric pressure, wind speed, wind direction, rainfall, and photosynthetically active radiation (PAR). In addition, the program collects monthly nutrient and chlorophyll A samples and monthly diel samples at one SWMP data logger station. Data is Federal Geographical Data Committee-compliant and available via the Reserve System Centralized Data Management Office.

2. **Biotic Characteristics:** As funds are available, reserves are focusing on monitoring habitats and biodiversity.

3. **Watershed and Land Use Classifications:** The reserve system is examining the link between watershed land use and coastal habitat quality by tracking and evaluating changes in coastal habitats

and watershed land use/cover. This element is guided by the Reserve System Habitat Mapping and Change Plan.

Building on these foundational elements, the reserve system is developing a network of sentinel sites and the capacity to assess the impact of sea level/lake level changes and inundation on the diverse set of coastal vegetative habitats represented in the system. Reserves are implementing a suite of activities, as described in the 2012 Reserve System Sentinel Site Guidance Document, to assess the relationship between vegetative communities (marsh, mangrove and submerged aquatic vegetation) and sea level. Reserves are adding surface elevation tables and monitoring pore water chemistry along vegetation monitoring transects and linking their SWMP to a network of specialized spatial infrastructure to allow precise measurement of local sea level and lake level changes and subsequent impacts to key habitats. The reserve system is working in partnership with NOAA's National Geodetic Survey and the Center for Operational Oceanographic Products and Services to support the development of sentinel sites.

4.1.2 He'eia NERR Research and Monitoring Program Context

Continued global decline of marine resources highlights that conventional management approaches simply cannot meet the challenges facing coastal ecosystems today (McLeod & Leslie 2009). Ecosystem-based management (EBM) is a long-term, integrated management approach that recognizes humans are a necessary part of and have significant influences on their environments. EBM embodies a fundamental shift away from ineffective conventional management paradigms that are frequently short term, reactionary, suffer jurisdictional limitations, and consider humans to be independent of nature and inconsistent with conservation goals (McLeod & Leslie 2009). As such, EBM advocates argue for a new holistic, resilience-based approach to oceans management, which has been heralded as "a critical new course for marine management" (Science 2009). Among Pacific Islanders, however, EBM is far closer to the traditional management system practiced for centuries prior to Western contact than are conventional management practices or contemporary restoration strategies.

The resource management system of ancient Hawai'i was based on the fact that all lands and natural resources were held in trust by the ali'i (chiefs) with harvest rights carefully overseen by a konohiki (expert resource manager) who was responsible (with their life) for the coordinated stewardship of all natural resources and extractive activities under their domain (the ahupua'a). The ahupua'a system constituted a carefully regulated and sustainable management strategy that integrated watershed, freshwater and nearshore marine resources based on the fundamental linkages between all ecosystems from the peaks of the mountain to the horizon of the sea (reviewed by Jokiel et al. 2010). Under this system, Native Hawaiians are one of the few societies documented to live entirely sustainably for centuries (off the local resources without any external subsidy), and were able to support a population of up to a million people, without any appreciable decline in marine resources when managed carefully (Kirch 1985; Kittinger et al. 2011). In contrast, a population of 1.3 million people today in the state gets over 90% of food from importation, and

many argue could not survive for more than a few weeks without that subsidy (Jokiel et al. 2010). It is important to emphasize the "carefully managed" caveat, because there are accounts of periodic famine, such as a "severe deficiency of fish" (Ellis 2004) indicating that resources have always been sensitive to overexploitation if not managed properly.

Thus, the movement towards EBM is particularly welcome and familiar among Pacific Islanders. The question remains how best to implement this strategy, and what exactly constitutes EBM as an explicit adaptive management strategy to maximize resilience and sustainability of ecosystem services desired by all stakeholders. The basic premises of EBM are to: 1) prioritize the health and function of the entire ecosystem over the needs of any individual activity or special interest group; 2) be place-based with natural boundaries; 3) account for multiple interactions, and how human actions both within and outside the place can influence or be influenced by management; 4) integrate the concerns of the environment, society, economy and human institutions; 5) consider humans as part of the system and maintain access to cultural ecosystem services demanded by people; and 6) provide a mechanism for coordination among all responsible entities (McLeod & Leslie 2009). Despite widespread consensus on the general tenets of EBM, the specifics of the approach, and the ability to implement EBM, remain a considerable challenge (Levin & Möllmann 2015; Prellezo & Curtin 2015).

He'eia NERR has an unprecedented ability to contribute to this ongoing debate about EBM best management practices, because the konohiki lineage responsible for sustainable management for over two centuries before Western contact still exists. That is, the descendants of the konohiki lineage are active in resource management decisions in the ahupua'a today. Thus, He'eia NERR seeks to provide a unique perspective on how different ecosystem-based management strategies influence a broad array of services that contribute to a healthy and sustainable estuarine ecosystem in the face of ongoing anthropogenic impacts, and human use demands. The He'eia NERR plans to examine the ecosystem services provided by two management strategies: (1) an approach based on contemporary ecological restoration techniques to increase native species biodiversity, ecological resilience, and ecosystem integrity; and (2) an approach that embraces traditional Native Hawaiian management practices to return the ecosystem to a state that was realized within the traditional ahupua'a system. Both strategies seek to integrate the concerns of the environment, society, economy, and human institutions, but focus on different aspects of each.

The first management strategy of ecological restoration is typical of contemporary conservation projects where the primary goal is to restore a damaged or degraded ecosystem to its historical trajectory by using pre-human conditions as the starting point for restoration design (SER 2004). This is a generally accepted approach that is advocated by most federal and state agencies, and is on a continuum of EBM approaches with an emphasis on ecosystem recovery (SER 2004).

The second management strategy based on the ahupua‘a system is an EBM approach successfully employed by Native Hawaiian cultural practitioners in He‘eia for at least 600 years prior to Western contact. Its essential premise is to care for the land and water so that it can in turn care for human sustenance (Jokiel et al. 2010; Bahr et al. 2015).

By measuring the suite of ecosystem services provided by each management strategy, the He‘eia NERR intends to evaluate these approaches within the He‘eia NERR boundaries to create an integrated approach that makes the He‘eia NERR a model for EBM strategies for Pacific Island estuarine ecosystems.

4.1.3 He‘eia NERR Research and Monitoring Program Capacity

The University of Hawaii’s HIMB is the managing state partner for the He‘eia NERR program. HIMB is also the main organization that has been conducting ecological research and monitoring in Kāne‘ohe Bay since its establishment in 1951 (HIMB 2015). HIMB is directed by its Strategic Plan (HIMB 2010) to be a world-class center for research on tropical marine ecosystems. From its research on large marine predators to the microbial foundations of estuarine and marine communities, HIMB is building a knowledge base that starts with relevant science, integrates public outreach, and concludes with providing recommendations for prudent management of coastal ecosystems.

Located on Moku o Lo‘e, HIMB is surrounded by 64 acres of coral reef designated by the State of Hawai‘i as the Hawai‘i Marine Laboratory Refuge which is used for research activities only. HIMB offers cutting edge research facilities for faculty, students, and visiting scientists. Research that HIMB is conducting in Kāne‘ohe Bay covers a broad range of topics, such as coral bleaching and disease, symbiosis, ocean acidification, marine microbial ecology, fisheries and top predator research, aquaculture and fish physiology, and biogeochemistry and biophysical analysis of reef systems.

HIMB’s efforts to engage the local community in research activities is in line with the research and monitoring goals and objectives developed for the He‘eia NERR. For example, HIMB maintains a database, accessible to the community, on the results of research conducted annually through its Pauley Program (workshops and short courses organized annually at HIMB) since 1983.

In addition to being one of the most intensively studied estuarine coral reef ecosystems on the planet (Bahr et al. 2016), the extensive history of study has already been compiled and made publically available through the Kāne‘ohe Bay Information System (KBIS - https://sites.google.com/site/kbisathimb/) as the foundation for the future Site Profile. Currently, the Hawai‘i Department of Health monitors water quality in He‘eia Stream and reports every 2 years on various water quality parameters such as total nitrogen, total phosphorous, total suspended solids, and turbidity. Additionally, many researchers at HIMB and on the main campus of UH at Mānoa have established and ongoing projects that can be leveraged by the establishment of the He‘eia NERR Research and Monitoring program such as:

Henrietta Dulai (University of Hawai‘i at Mānoa): interested in water availability throughout the watershed, Dr. Dulai has worked on surface water and groundwater resources, their quality and quantity for the past several years. Her future interests include:

- expected changes in the water budget with climate change and sea level rise - seawater intrusion to the coastal aquifer, lower precipitation rates resulting in less water availability
- expected changes in the water budget and water quality with land use change - conversion of the coastal wetland to taro will change terrestrial as well as marine water quality
- water as a pathway that connects terrestrial and fishpond/reef environments - stream and groundwater discharge to the coast, their relative importance for nutrient and sediment transport, are asks whether other emerging concerns such as pesticides, pharmaceuticals or other water-borne pollutants important?

Kathleen Ruttenberg & Margaret McManus (University of Hawai‘i at Mānoa): often working in collaboration, these researchers are interested in the way in which the magnitude and nature of fluxes of both sediment and nutrients (nutrients, carbon, DO, pH, etc.) throughout the watershed will change under differing land-use practices and resource management strategies. Prof. Ruttenberg also has a time series of biogeochemical parameters going back to 2007 that provides an invaluable baseline against which future changes can be measured. Their future interests include:

- time series of water and sediment flux, the associated dissolved and particulate chemistry, and the processes that control nutrient cycling in this system
- characterizing the nature of sediment and quantifying nutrient fluxes between the seabed and water column
- characterizing the nature of organic matter delivered across the ahupua‘a
- characterizing the impact of invasive alien macroalgae and mangrove removal on the benthic environment and nutrient biogeochemistry of the area

Flo Thomas & Sherril Leon-Soon (Hawai‘i Institute of Marine Biology): interested in the interaction of physics and biology, Dr. Thomas and her student Sherril have been collaborating with others on this list to look at the fluxes and fate of nutrients throughout the watershed, which species are using them, and trying to understand how traditional management practices such as taro patches (lo‘i kalo) and fishponds (loko i‘a) modify the flux of nutrients and sediment contained in the water that travels through the wetlands and out onto the reef flats. Further, **Hokulani Aikau** and others have collaborated with these researchers to provide information gathered by conducting interviews with keepers of knowledge (kupuna) to map historical land and resource uses.

Craig Nelson (University of Hawai‘i at Mānoa): is interested primarily in microbial activity and microbial community dynamics and how these impact environmental geochemistry and cycling of dissolved organic matter. His current research, supported by a competitive grant awarded through Hawaii Sea Grant, seeks to use microbial source tracking to understand the location and passage of wastewater seeps from cesspools in the surrounding inhabited area throughout the watershed. His future interests revolve around supporting a more holistic "ridge to reef" framework to understand the biogeochemistry of the system in collaboration with the other researchers listed in this section.

Mike Rappe (Hawai‘i Institute of Marine Biology): focuses primarily on anthropogenic and environmental forcing on microbial community structure across the bay. His current research, supported by a grant from the National Science Foundation (NSF) to work on population genetics and genome dynamics of planktonic marine microbes throughout the greater Kāne‘ohe Bay watershed. This funded project includes time series sampling for a number of water column parameters that will be of relevance and provide a baseline to future monitoring efforts in He‘eia NERR.

Brian Glazer (University of Hawai‘i at Mānoa): interested in the various biogeochemical processes (such as seasonal nutrient loading, sediment-water interface fluxes, and the scales of temporal/spatial variability in such processes) he is currently funded by NSF to deploy a miniaturized sensor array across the proposed He‘eia NERR. Specifically, his group has developed accurate, precise, and near-real-time remote sensing instruments that can provide data on biologically relevant scales that may contribute to national SWMP goals.

Erik Franklin (Hawai‘i Institute of Marine Biology): interested primarily in examining ecological structure, function, and interactions of organisms throughout the proposed He‘eia NERR site. Research to date has focused on species that are critical components for ecological function or food production as either target species or predators, prey, or competitors of target species. Future interests include ecological surveys to understand community composition, population dynamics, and migration into and out of the fishpond as well as life history analyses to understand growth and reproduction of target species inside the fishpond and as a result of changing land-use and resource management strategies within the site.

Rob Toonen, Brian Bowen & Steve Karl (Hawai‘i Institute of Marine Biology): often collaborating, this group is interested primarily in population and conservation genetics, connectivity, selection and local adaptation. Their work to date has shown that dispersal occurs at a much finer scale than previously assumed, and that population structuring of most coral reef species is at a scale of island-by-island or less. Their ongoing and future work seeks to quantify the amount of exchange from within the proposed He‘eia NERR site to the surrounding waters, and between Kāne‘ohe Bay and other sites along the windward coast of O‘ahu.

Paul Jokiel, Ku‘ulei Rogers & John Stimson (Hawai‘i Institute of Marine Biology): the ongoing Coral Reef Assessment and Monitoring Program (CRAMP) provides data from permanent coral monitoring sites established around the bay going back to 1997. This long-term monitoring can be integrated with the He‘eia

NERR efforts and continued to provide nearly 20 years of critical baseline data prior to establishment of the site. Valuable contributions of this prior work include documented past bleaching events, alien algae outbreaks, freshwater kills and other major disturbances to the reef communities of Kāneʻohe Bay and provide a rich context against which to assess changes under the proposed resource management strategies. In addition to this rich historical dataset, this group has also worked to reconstructed long-term historical baselines of the proposed site, documented ecological and community changes in the bay communities through time, worked on the integration of western science with traditional ways of knowing, and developed conceptual and mathematical models for predictions of expected changes to coral reef ecosystems in Hawaiʻi under future climate change.

Kim Falinski (The Nature Conservancy): a recent graduate of the University of Hawaiʻi at Mānoa, Dr. Falinski is primarily interested in sediment and nutrient retention of the wetland under contemporary and traditional management strategies. Her future research interests include the role of taro ponds (loʻi kalo) in sediment and nutrient retention, as well as their potential role in flood mitigation, food security and as habitat for endemic and endangered species.

Other relevant ongoing research efforts in the Heʻeia NERR include those conducted by UH, State and Federal agencies (detailed in the Heʻeia Resilient Lands and Waters Initiative document compiled by the Pacific Islands Climate Change Cooperative, NOAA Sentinel Site Program, and U.S. Environmental Protection Agency). This list provides an idea of the scope and breadth of research currently underway and the capacity available to the site. Additionally, the University of Hawaiʻi has the School of Ocean and Earth Science and Technology (SOEST) Laboratory for Analytical Biogeochemistry (S-LAB) measures dissolved inorganic and organic nutrients (P, N, Si); dissolved organic and inorganic carbon; dissolved oxygen; salinity; solid-phase carbon, nitrogen, sulfur and phosphorus; and chlorophyll-a in natural waters, sediments, soils, and vegetation that may contribute to the NERRS SWMP data. The in-house S-LAB provides analysis services at a reasonable per sample cost, as well as access to several instruments for user-based sample analysis (http://www.soest.hawaii.edu/S-LAB/) will provide an essential service to the site upon establishment of the SWMP plan.

4.1.4 Heʻeia NERR Research and Monitoring Program Research and Delivery Plan

Over the next 5 years, the Heʻeia NERR's Research Coordinator will provide the program support to begin a comprehensive and integrated research and monitoring program at Heʻeia NERR to meet the following research and monitoring program goal and objectives using the framework outlined below.

We propose to address the question of the ecosystem services that each management strategy provides in the framework of a coupled Social-Ecological System (SES), or a human-dominated anthroposystem, that explicitly considers the linkages between social system structural traits, human activities, ecosystem services, and human well-being in coastal communities (inset from Kittinger et al. 2012). Within this evaluation framework, we expect that contemporary and traditional Hawaiian approaches will each support multiple and different ecosystem services. Success of each can be evaluated using subsets of a continuum

of ecosytem services, not only in the context of the He‘eia NERR being restored to a more resilient and sustainable state, but also to increase our understanding of how different strategies for ecosystem based management (EBM) can be employed in other similar ecosystems within the SES framework.

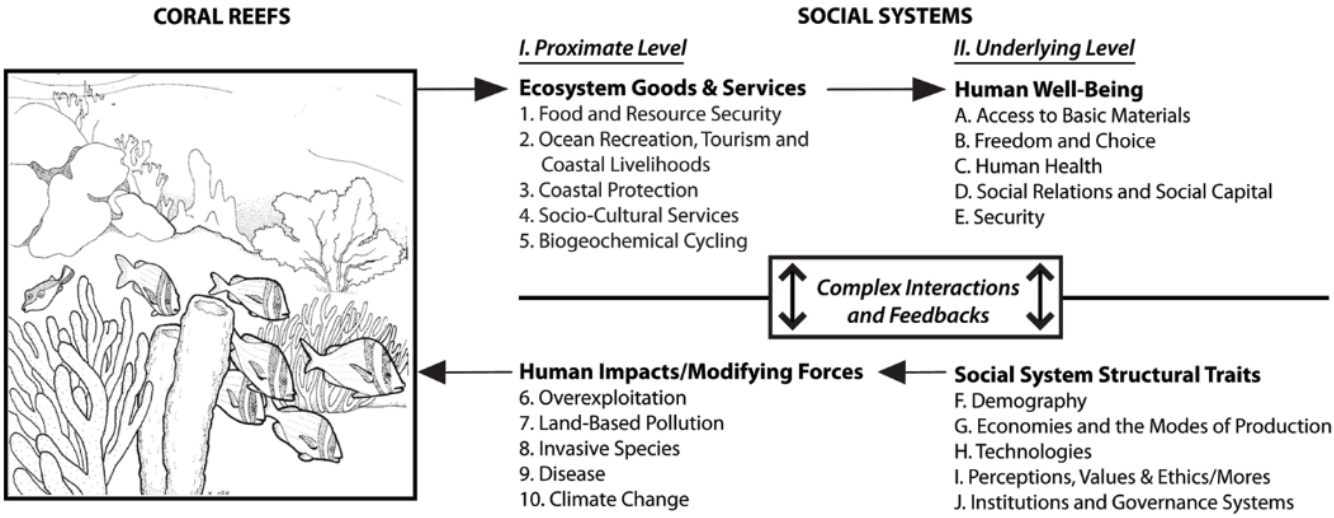

Figure 4.1. Illustration from Kittinger et al. 2012

4.1.5 Research and Monitoring Future Needs and Opportunities

During focus group meetings (See Section 2 on Community Engagement) the site partners identified the following research needs for the He‘eia NERR:

- Establish baseline environmental conditions of the ahupua‘a of He‘eia that can then guide future research and monitoring efforts at He‘eia NERR.
- Incorporate traditional Hawaiian knowledge and practices to inform and establish baseline environmental conditions.
- Conduct research that promotes our understanding of the interconnectedness of the ecosystems (from the mountains to the ocean) in the ahuapua‘a of He‘eia (See Section 4.1 on current research in the area).
- Develop a system to coordinate various independent social, cultural, and natural resource related research and monitoring conducted in the ahupua‘a of He‘eia so as to avoid duplication of effort and better guide future research needs.

- Contribute to and learn from the larger national and international community about climate change impacts and adaptations.

These ideas were the initial basis for the research and monitoring objectives developed for the management plan. Designation of the He‘eia NERR is viewed by the site partners as an opportunity to provide a framework to enhance coordination for the various ongoing as well as future research and monitoring needs in the ahupua‘a of He‘eia. Local cultural and scientific expertise and existing research facilities not just at HIMB but, also those at the site partners’ locations such as He‘eia Fishpond and the He‘eia CDD would be available to support and grow the He‘eia NERR research program. Over the next 5 years, the He‘eia NERR’s Research Coordinator will provide the program support to begin a comprehensive and integrated research and monitoring program at He‘eia NERR to meet the following research and monitoring program goal, objectives, and strategies.

Figure 4-2. Hawai‘i Institute of Marine Biology (HIMB) on

Moku o Lo‘e

(Photo courtesy of HIMB)

Goal 1

Increase our understanding of the effects of human activities and natural events to **improve informed decision making** affecting the He‘eia estuary, coastal ecosystems, and ultimately the entire ahupua‘a of He‘eia.

Objective 1 Baseline environmental data informs researchers' understanding of the magnitude of changes in the various Heʻeia ecosystems.	
Strategies to meet Objective 1	**Outcomes**
Strategy 1(a): Document cultural and archaeological information to establish historical and baseline conditions in the ahupuaʻa of Heʻeia, including the waters of Kāneʻohe Bay	Ethnographic interviews with kūpuna document what they considered an optimal and healthy state of Kāneʻohe Bay and the ahupuaʻa of Heʻeia. The ethnograhic and historical data for the Heʻeia area inform research.
Strategy 1(b): Explore the development of a reserve-specific repository to house historical, cultural, and scientific information conducted in Heʻeia.	Heʻeia historical, cultural, and scientific data and information are compiled and available digitally for internal and external users.
Strategy 1(c): Heʻeia NERR staff will identify the gap areas that need additional research.	Researchers at the Heʻeia NERR shall be informed of other research being conducted in the area and possible synergies and data gaps.
Strategy 1(d): Heʻeia NERR staff and partners develop a site profile for the Heʻeia NERR by collecting relevant information.	By 2019, a completed site profile is provided to NOAA OCM and interested researchers. Heʻeia NERR shall have a complete and approved site profile.
Strategy 1(e): Support research studies on how floodwaters, sediment, and nutrients move through the ahupuaʻa of Heʻeia.	Researchers and coastal managers have an improved understanding of how water, sediment, and nutrients movement studies in the through the ahupuaʻa of Heʻeia are conducted.
Strategy 1(f): Create opportunities to conduct research within the ahupuaʻa, potentially outside the Heʻeia NERR boundaries, that provides relevant information about impacts on the entire ahupuaʻa of Heʻeia, to inform the long-term vision of a healthy Heʻeia ahupuaʻa.	The long-term vision of the Heʻeia ahupuaʻa is informed by research conducted within the ahupuaʻa.
Strategy 1(g): Conduct scientific research and monitoring that will provide information on climate change, water quality, estuary habitat change, and other topics of local and national interest and significance.	Information on topics of local and national interest and significance shall be developed from research and monitoring conducted in the Heʻeia NERR.
Strategy 1(h): Establish 4 water quality SWMP stations and 1 weather station.	Heʻeia NERR SWMP data contributes to local understanding of changes in the Heʻeia ecosystem. By 2018, Heʻeia NERR SWMP program is integrated with the national monitoring program (i.e. NERRS, NOAA Sentinel Sites and IOOS).
Strategy 1(i): Implement baseline biodiversity surveys with Heʻeia NERR site partners.	Comprehensive biological survey data informs Heʻeia NERR site profile and is available to use by researchers.

Strategy 1(j): Establish a site experimental design that supports ecosystem-based management research approach.	Treatment and control areas are identified within each major ecosystem type for the He‘eia NERR.
Strategy 1(k): Recruit and maintain reserve research and monitoring staff.	Staff are supporting the development and implementation of He‘eia NERR research programs.

Objective 2 Coordinate independent research and monitoring efforts in the ahupua‘a.	
Strategies to meet Objective 2	**Outcomes**
Strategy 2(a): Develop a comprehensive long-term environmental monitoring program for He‘eia NERR in upland, estuarine, and marine ecosystems.	Researchers and partners improve their understanding of short and long-term changes within the He‘eia ahupuaa.
Strategy 2(b): He‘eia NERR staff coordinates implementation of the He‘eia NERR monitoring program with site partners.	The He‘eia NERR monitoring programs are linked to local monitoring efforts.
Strategy 2(c): Facilitate the coordination, collaboration, and distribution of all scientific investigations conducted within the ahupua‘a of He‘eia (to the extent legally permissible) to minimize duplication of research and identify the gap areas that need additional research.	Researchers at the He‘eia NERR shall be informed of other research being conducted in the area and possible synergies and data gaps.
Strategy 2(d): Recruit and maintain He‘eia NERR research and monitoring staff.	Staff support He‘eia NERR implementation of SWMP and other key terrestrial and marine monitoring efforts.
Strategy 2(e): Collaborate with new partners conducting relevant research and monitoring efforts	New external partnerships are established.

Objective 3 Integrate traditional knowledge and research in the He‘eia NERR that will better reflect and inform community decision making toward creating a sustainable ecosystem.	
Strategies to meet Objective 3	**Outcomes**
Strategy 3(a): Create opportunities for Native Hawaiian practitioners, scientists, (including those with expertise in traditional and customary practices) and others (including those with expertise in contemporary science) to collaborate and develop contemporary mo‘olelo (stories) reflecting change that reflect and track changes in the He‘eia ahupua‘a over time.	Contemporary mo‘olelo for He‘eia ahupua‘a inform the collective understanding of recent changes within the ahupua‘a.
Strategy 3(b): Coordinate periodic community meetings to inform the community about upcoming scientific research opportunities, gather input to guide further research, and share ongoing research results.	At least 2 local communities are knowledgeable of the ongoing and planned research within the He‘eia NERR.
Strategy 3(c): Work with site partners to share ecosystem-based best management practices that support improved management of the He’eia ahupua’a.	Ecosystem-based best management practices are applied by communities to improve coastal ecosystems.
Strategy 3(d): Creates opportunities for the “synthesizers” or “bridgers”[10] of traditional customary practices and contemporary science to collaborate and share their findings and recommendations.	Site partners and the community are knowledgeable of the synthesizers’ mana‘o about the nexus of traditional practices and contemporary science.
Strategy 3(e): Recruit and maintain He‘eia NERR educational and cultural staff.	Staff are supporting the integration of traditional knowledge and scientific research in the He’eia NERR.

10 “*Synthesizers/bridgers” are defined as individuals who apply different ways of knowing including traditional practices and contemporary science within the context of the He’eia NERR.*

4.2 Education Program

4.2.1 NERRS Education Program

The NERRS mission includes an emphasis on education, interpretation, and outreach. Education at each reserve is designed to fulfill the Reserve System goals as defined in the regulations (15 CFR 921[b]):

- Enhance public awareness and understanding of estuarine areas and provide suitable opportunities for public education and interpretation.
- Conduct and coordinate estuarine research within the system, gathering and making available information necessary for improved understanding and management of estuarine areas.

To sustain these system goals, the *2011-2016 Reserve System Strategic Plan* outlines education objectives that support the focus areas of climate change, habitat protection, and water quality:

- Enhance the capacity and skills of teachers and students to understand and use reserve system data and information for inquiry-based learning.
- Increase estuary literacy and promote active stewardship among public audiences through the development and delivery of tools and programs addressing climate change, habitat protection, and water quality.

The reserve system provides a vehicle to increase understanding and awareness of estuarine systems and improve decision-making among key audiences to promote stewardship of the nation's coastal resources. Education and interpretation incorporate science-based content into a range of programs and methodologies that are systematically tailored to key audiences around priority coastal resource issues.

Reserves conduct formal and informal education activities, as well as outreach activities that target culturally diverse audiences of educators and students, environmental professionals, resource users, and the general public. Education and public programs, interpretive exhibits and community outreach programs integrate elements of reserve system science, research, and monitoring activities and ensure a systematic, multifaceted, and locally focused approach to fostering stewardship.

The reserve system is committed to preparing tomorrow's future leaders with the knowledge and understanding of our nation's oceans and coasts to be responsible stewards. To fulfill this commitment, the Reserve System has created the K-12 Estuarine Education Program (KEEP) to increase the estuary literacy of students, teachers and the general public. The KEEP helps students and teachers learn about essential coastal and estuarine concepts, develop data literacy skills and strengthen their critical thinking, team building, and problem-solving skills. K-12 and professional development programs for teachers include the

use of established coastal and estuarine science curricula aligned with state and national science education standards and frequently involve both on-site and in-school follow-up activity.

Community education is another priority for the reserve system. Community education programs foster behavioral change to promote resource conservation. These programs work with audiences whose choices directly impact the integrity of our estuaries and their associated watersheds.

4.2.2 He‘eia NERR Education, Training, and Interpretation Program Context

Several academic and community-based educational programs have been and continue to be organized in He‘eia, independent of the nomination of He‘eia NERR. The following paragraphs describe some of the education, training, and interpretive programs routinely organized by some of the He‘eia NERR site partners such as HIMB, Paepae o He‘eia, and Kāko‘o ‘Ōiwi.

HIMB, as mentioned above, is a research institute at UH at Mānoa. Housed in the University’s School of Ocean and Earth Science and Technology (SOEST), HIMB offers a variety of undergraduate and graduate courses, seminars, and research opportunities for undergraduate and graduate students in marine and estuarine sciences. In addition to its academic programs, HIMB offers educational programs to individuals, families, and school (K-12) and community groups. These include science inquiry programs for high school students; various teacher workshops, guided walking tours of Moku o Lo‘e that describe the island’s natural and human history; the Expedition to Moku o Lo‘e — a 3-hour program during which members of the community can be part of a marine biology research team on the water and in the lab; and Moku o Lo‘e Marine Science Overnights, in which the community and youth groups participate in data collection and hypothesis building activities while staying at the field station. HIMB also organizes community and citizen science research programs with partners in the ahupua‘a, at locations such as He‘eia Fishpond and wetlands. HIMB thus provides a full spectrum of formal and informal educational opportunities for all types of participants along the learning continuum. A central mission is to create pathways to marine science research and management careers for students from Hawai‘i school systems.

Paepae o He‘eia runs the Ka ‘Ai Kamaha‘o program, which engages participants from the community, “keiki to kūpuna, in culturally relevant and academically rigorous studies aimed at bridging traditional and contemporary knowledge systems. The eco-cultural projects consist of mālama loko i‘a, place-based knowledge and ecological-based studies that foster values and concepts of traditional fishpond management” (Paepae o He‘eia 2015). Through its He‘eia Ahupua‘a Internship program, Paepae o He‘eia offers a unique opportunity to youth and young adults to work outdoors and learn the science and skills to restore, preserve, and protect not just the fishpond but the entire mauka/makai ahupua‘a relationship.

Figure 4-3. High school students learn from transect surveys of reefs at HIMB's summer internship program

(Photo courtesy of Hawai'i Institute of Marine Biology)

Paepae o He'eia also organizes educational field programs for K-12 and college students. For example, Paepae o He'eia has partnered with several Hawaiian-based charter schools. Students from these schools use the fishpond as a classroom and a living lab, examine the ecology of the fishpond and estuarine environments, and develop a deeper understanding of how the fishpond works. A variety of other schools in the State's Department of Education system also participate in Paepae o He'eia's education activities and learn about the ecology of coastal ecosystems, the estuarine environment, and Hawaiian fishponds. The Center for Hawaiian Studies at UH offers the Mālama Loko I'a course, during which students meet at the fishpond every week to learn about traditional fishpond management and gain hands-on experience. The students' work helps inform management decisions that Paepae o He'eia makes regarding restoration and fish and limu culture.

Figure 4-4. K-12 students participate in educational activities at the He'eia Fishpond

(Photos courtesy of Paepae o He'eia)

Kākoʻo ʻŌiwi implements the Māhuahua ʻAi o Hoi (Re-growing the fruit of Hoi), a long-range project to restore agricultural and ecological productivity to nearly 405 acres within the wetlands of Heʻeia. The group organizes monthly community workdays that involve activities like weeding, maintaining existing loʻi kalo, building new loʻi kalo and ʻauwai (irrigation ditches), and clearing invasive vegetation. Through these activities, participants learn the ecological and cultural foundations of traditional Hawaiian agriculture and how upland activities affect the estuary and bay waters.

The educational programs at Heʻeia NERR complement the national priorities of ecosystem-based management and ecosystem protection and restoration—the sustainable practices on land, the nearshore marine environment, and at the fishpond in Heʻeia are the basis for educational programs highlighting the importance of the entire ecosystem. These programs educate students and visitors on the state of invasive species in Kāneʻohe Bay, the effects of erosion, nonpoint source pollution, removal of any plants or animals from Kāneʻohe Bay, and climate change on the ecosystem, and the nexus of human activities and traditional agriculture and the natural ecosystem. At the state level, the perspective of building capacity for community participation in resource management through education and outreach is also being achieved in Heʻeia through site partners' educational programs.

4.2.3 Heʻeia NERR Education, Training, and Interpretation Program Capacity

Educators at HIMB and on the main campus of UH Mānoa have established and ongoing projects that can be leveraged by the establishment of the Heʻeia NERR Education program. Examples of these educators and programs include:

Dr. Judy Lemus is a tenured faculty specialist at HIMB. With a strong interest and focus in community based participatory research, she develops educational and professional development opportunities for undergraduate and graduate students, teachers, and community members. She has worked closely with both Paepae o He'eia and Kako'o Oiwi on programs that engage community interns and educational docents in scientific research. She also creates outreach materials for these programs and has developed an iPhone app that provides virtual and on-site walking tours of He'eia Fishpond (with over 1100 downloads). She currently serves as the president of the Board of Directors for Paepae o He'eia, and is a member of the Kāneʻohe Bay Regional Council, a governor appointed group that provides input to state agencies on recreational, commercial and educational activities in Kāneʻohe Bay.

Dr. Malia Rivera is a tenured faculty specialist at HIMB that has led an emerging program in K-12 marine science education at HIMB, specifically aimed to better serve the Hawaii's students from local schools. Her projects and programs focus on providing pathways for Hawaii's underrepresented students to enter STEM careers, and includes marine science curriculum for K-12, intensive summer programs for high school students and early undergraduates, scientific inquiry focused teacher professional development workshops, research internships for high school and early undergraduate students at HIMB, and training

science focused graduate students in teaching and pedagogy in place and culturally based settings. She also led the effort to fundraise, design and build the HIMB Marine Science Research Learning Center at Moku o Loʻe, a facility dedicated to outreach and education programming at HIMB, as well as secured funding to acquire a 45 passenger vessel to support outreach and education for HIMB's education programs.

Mark Heckman is an education specialist faculty at HIMB where he oversees the Community Education Program. Mark's interests span a wide range of subject matters and age groups that focus on creating positive science experiences for all ages and pathways to science for those that have the greatest need. Mark is currently developing sustainable long term programs to provide culturally relevant science training opportunities and access for students, families and the public. His current collaborations and grants include programs with the Pacific American Foundation to provide pathways into science for Windward Oʻahu students, the Smithsonian Institution, the Robert Wood Johnson Foundation, NOAA and others. He is the past chair of OCEANIA, the local chapter of the National Marine Educators Association, vice chair of Hui o Koʻolaupoko, a Windward Oʻahu non-profit organization that works to improve water quality), and serves on the advisory committees for the Nalu Studies program (focusing on high risk and non-traditional students) and the Watershed Investigations, Research, Education and Design (WIRED) program for grades 6-12 students.

4.2.4 Heʻeia NERR Education, Training, and Interpretation Program Delivery Plan

The He'eia NERR will provide all learners with opportunities to experience and engage with the Heʻeia ahupuaʻa ecosystem. Delivery will include place-based STEM links with traditional ecological and cultural knowledge programs provided by Heʻeia NERR partners. These programs will be coordinated with each other to emphasize the connectedness of the different components of the ecosystem: land-based, estuarine, and coastal marine environments. The education plan will also include integration with the Kāneʻohe Bay Information System and other web-based or mobile platforms for delivering information and programming to broader audiences.

4.2.5 Heʻeia NERR Education Future Need and Opportunities

The education-related needs identified by the site partners include the following:

- Create opportunities to coordinate academic and community based educational programs that are currently organized independently by the site partners;
- Align Heʻeia NERR education programs with the Hawaiʻi Department of Education and Next Generation Science Standards;
- Link research program (including its basis on ecosystem based management) to the education program;

- Incorporate traditional Hawaiian knowledge and skills in teaching the students and the community about Hawaiian estuaries and the ahupua‘a land management system;
- Involve kūpuna in educational activities and site tours of the ahupua‘a of He‘eia so as to integrate the cultural component into educational activities;
- Utilize He‘eia NERR as a field site for high school, undergraduate and graduate research and experiential learning opportunities. Infuse STEM training throughout the various programs to help create pathways for local students to continue on to undergraduate and graduate STEM and natural resource management related degree programs; and
- Provide opportunities to improve STEM and Environmental literacy amongst all members of the community.

As discussed above, the site partners of He‘eia NERR already have several independently organized educational programs and facilities available for K-12 students as well as for the community at large. The community identifies an overarching need to integrate their numerous independent educational programs and avoid duplication of effort and resources. The future education program at He‘eia NERR is seen as an opportunity by the community that would meet these needs by creating a platform that will allow for collaboration among the site partners’ independent educational programs. This need identified by the community also presents an opportunity for the newly designated He‘eia NERR to build a comprehensive educational program within the next 5 years that spans the learning continuum and provides pathways for local students to explore resource management, science research and STEM careers. The He‘eia NERR educational program shall build upon the existing resources, expertise, and facilities available to develop education programs such as K-12 Estuary Education Program (KEEP), Teachers on the Estuary (TOTE) program, as well as research and stewardship experiences for community, high school and college students, and community engagement opportunities for science focused graduate students.

Over the next 5 years, the He‘eia NERR Education Coordinator will develop an education, training, and interpretation program in He‘eia that will integrate and build on various ongoing academic and community-based educational programs in He‘eia, to meet the following goal and objectives.

Goal 2

Develop a place-based education and training program for the He‘eia NERR that **inspires and educates the community about estuaries, coastal ecosystems, and traditional Hawaiian practices**, such as lo‘i and loko i‘a, that mālama (nurture) these systems sustainably.

Objective 4 Increase student, educator, and community understanding of estuaries in general and in particular Hawaiian estuaries, coastal habitats, and the ahupuaʻa land management system.	
Strategies to Meet Objective 4	**Outcomes**
Strategy 4(a): Heʻeia NERR educational programs build on existing efforts and cultural resources (e.g. the poster by Marilyn Kahalewai of a traditional ahupuaʻa) and incorporate a traditional cultural perspective.	At least 50% of students and teachers participating in Heʻeia NERR educational programs demonstrate improved understanding of traditional Hawaiian culture.
Strategy 4(b): Kūpuna make traditional Hawaiian cultural information available to the Heʻeia NERR and local communities.	Local communities and the NERRS network have improved access to educational and cultural resources based on the Heʻeia ahupuaʻa.
Strategy 4(c): Heʻeia NERR will include kūpuna in Heʻeia site tours as part of a cultural orientation to the Heʻeia NERR site.	At least 50% of Heʻeia NERR visitors experience a cultural orientation to the Heʻeia NERR.
Strategy 4(d): Kūpuna testimonials are included as part of a cultural orientation to the Heʻeia NERR site.	At least 50% of Heʻeia NERR visitors experience a cultural orientation to the Heʻeia NERR.
Strategy 4(e): Heʻeia NERR staff develop programs that incorporate information about the entire ahupuaʻa of Heʻeia.	At least 50% of students and others participating in Heʻeia NERR programs have an improved understanding of the He'eia ahupuaʻa
Strategy 4(f): Provide site-specific educational experiences that facilitate hands-on exploration of the upland, estuarine, and marine environments in the Heʻeia estuary with site partners.	Annually, at least 2 education and training events at the Heʻeia NERR include hands-on activities coordinated with site partners.
Strategy 4(g): Translate Heʻeia NERR estuarine science and monitoring data to develop data visualizations for use in educational and training programs.	Increased understanding of estuarine science, monitoring data and the Heʻeia estuary.
Strategy 4(h): Heʻeia NERR staff will develop and establish the system- wide K-12 Estuarine Education Program (KEEP) at the Heʻeia NERR.	Heʻeia NERR has a NOAA approved KEEP program in place.

Strategy 4(i): Recruit and maintain He‘eia NERR educational, stewardship and cultural resource staff.	Staff are supporting He‘eia NERR educational, training and interpretation programs.
Strategy 4(j): Establish and maintain He‘eia NERR website.	Increased understanding of estuarine science, monitoring data and the He‘eia estuary.

Objective 5 Provide a comprehensive framework to integrate and enhance coordination and effectiveness of place-based education and training programs that have been initiated independently by the He‘eia community.	
Strategies to Meet Objective 5	**Outcomes**
Strategy 5(a): Collaborate with the Hawai‘i Department of Education (DOE) to explore ways to integrate state K-12 educational standards into He‘eia NERR education program curricula.	A pilot He‘eia NERR education program addresses state educational standards and is aligned with the K-12 curriculum for one elementary and one secondary grade band.
Strategy 5(a)1: Develop cultural standards and operating protocols for He‘eia NERR education, training, and interpretation programs at the He‘eia estuary with the assistance of stakeholders such as the KHCC and other native Hawaiian cultural practitioners in the He‘eia community. **Strategy 5(a)2:** The Stewardship and Cultural Resources Coordinator shall implement a cultural workshop with partners to coordinate discussions on cultural standards and protocols.	Place-based education programs at the He‘eia NERR incorporate and follow cultural protocols.
Strategy 5(c): Develop initiatives that allow the He‘eia NERR and site partners to coordinate and integrate aspects of their educational activities.	At least 2 site partners have integrated an educational program or aspects of their educational programs at the He‘eia NERR.

4.3 Stewardship Program

4.3.1 Stewardship in the Context of the He‘eia NERR

One of the key elements in establishing a NERR in He‘eia was the interest of the community in protecting and restoring the He‘eia estuary. Continuing that community support and involvement will require dedicated outreach to the public and key stakeholders to attract and retain the people that can help the He‘eia NERR accomplish its goals. Outreach will also establish close working partnerships with other groups that may be doing similar work to avoid duplication and wasted efforts, and to find new opportunities to partner and increase effectiveness.

Stewardship, including protecting and restoring the natural and cultural resources of the ahupua‘a of He‘eia, was one of the driving factors in the movement to establish the He‘eia NERR. The site partners each have a slightly different focus for stewardship projects, but have a common and overlapping commitment to sustainable natural and cultural resource management and conservation. They had the foresight to recognize that working together in a coordinated and integrated fashion would help everyone achieve their goals. The partners also recognized that becoming a NERR could help by providing a local and national program structure, technical support, and funding for research, education, training, facilities construction, and stewardship programs to help achieve common goals.

Figure 4-5. Stewardship activities such as restoring the fishpond wall teach the public about natural and cultural resources

(Photo courtesy of Paepae o He‘eia)

To help the He‘eia NERR and the national system achieve their vision, mission, goals, and objectives, the site partners are committed to implementing key natural and cultural resource management projects in the He‘eia NERR. These include the removal of invasive algae; introduction of native grazing urchins to control the spread of invasive algae; demonstration of traditional agricultural methods that rehabilitate the land and provide ecosystem services; restoration of native species’ habitats; and demonstration of traditional fishpond aquacultural practices that support estuary function and provide ecosystem services. He‘eia NERR staff will support the stewardship programs by providing technical assistance, monitoring, establishing baseline conditions for research, and planning assistance.

There are ongoing stewardship projects aimed at increasing the knowledge and awareness of priority coastal management issues such as invasive species, loss of habitat, erosion and sedimentation, nonpoint source pollution, water quality issues, agricultural development, and climate change impacts in the He‘eia area. Stewardship programs with He‘eia site partners help to build capacity for community participation in resource management through education and outreach.

4.3.2 He‘eia NERR Stewardship Needs and Opportunities

The site partners identified the following needs relative to stewardship:

- Increase understanding among the general public and coastal decisions makers about how human activities affect the He‘eia estuary.
- Provide opportunities and training on how the ahupua‘a land management system can be applied to address climate change, habitat restoration, and water quality in He‘eia watershed.
- Support ongoing restoration programs to improve the quality of coastal habitats.

Over the next 5 years, the He‘eia NERR Stewardship Coordinator will develop a stewardship program in He‘eia that will integrate and build on various ongoing academic and community-based educational programs in He‘eia, to meet the following goal and objectives.

Goal 3

The He‘eia NERR will engage various communities to create opportunities for collaboration to practice and promote stewardship that sustains cultural, biological, and natural resources.

Objective 6	
Integrate traditional knowledge and contemporary science to effectively address climate change, habitat restoration, and water quality.	
Strategies to Meet Objective 6	**Outcomes**
Strategy 6(a): Utilize historical photos, testimonials, and other information to document the land use history of the ahupuaʻa of Heʻeia and incorporate into Heʻeia NERR education and interpretative programs.	Visitors to the Heʻeia NERR indicate increased awareness of the interconnectedness of activities in the mauka and makai areas, including the history of cultural activities in the area and the effect changing uses has had on the ecosystem.
Strategy 6(b): Consult with the Koʻolaupoko Moku Kūpuna Council to develop methods for kūpuna to inform cultural and scientific education programs at the Heʻeia NERR.	Place-based cultural and scientific education programs at the Heʻeia NERR incorporate input from kūpuna.
Strategy 6(c): Develop and establish the Coastal Training Program to support training opportunities for targeted coastal decision maker audiences.	The Heʻeia NERR has a fully developed and NOAA approved Coastal Training Program.
Strategy 6(d): Provide technical assistance to site partners in support of ongoing traditional agricultural (taro loʻi) and aquaculture (Heʻeia Fishpond) practices	Measured improvements of targeted ecosystem services provided by traditional land use practices
Strategy 6(e): Collect and analyze ecosystem service data for each management approach implemented at the Heʻeia NERR.	Ecosystem service data inform strategies for adaptive management at Heʻeia estuary and other estuaries.

Objective 7
Engage and educate the community on the practices and values of the ahupuaʻa land management system; in other words, promote ʻāina momona and enhanced stewardship efforts by all sectors of the community, to increase their understanding of how human activities and natural events affect the estuary.

Strategies to Meet Objective 7	Outcomes
Strategy 7(a): Provide a variety of hands-on stewardship experiences to the community groups and visitors.	The community groups and visitors of the He‘eia NERR improve their understanding of ‘āina momona.
Strategy 7(b): Collaborate with partners to incorporate He‘eia NERR science, traditional knowledge and information in the rehabilitation of historical, agricultural and aquacultural resources within the He‘eia NERR.	The He‘eia NERR agricultural and aquacultural resources are managed sustainably to provide food security and other ecosystem services for local communities.

Objective 8 Become a leading repository of information for cultural, biological, and natural resources in the He‘eia estuary.	
Strategies to Meet Objective 8	**Outcomes**
Strategy 8(a): Organize and incorporate cultural and natural resource information from the broader community into the He‘eia NERR website and other accessible platforms.	Increased awareness of Heeia estuary resources and information.

Objective 9 Develop the tools, capacity and connections to increase public awareness across the community, island, state, nation, and the world of the ecological and cultural significance of the He‘eia estuary and ultimately the entire ahupua‘a of He‘eia.	
Strategies to Meet Objective 9	**Outcomes**
Strategy 9(a): Engage with site partners and other organizations such as local civic clubs to implement public outreach activities in the He‘eia ahupua‘a.	Communities and individuals gain an understanding of the ecological and cultural significance of the He‘eia estuary.
Strategy 9(b): He‘eia NERR staff utilize the expertise of cultural experts, such as the KHCC	Expertise of haku (ambassadors) are integrated into He‘eia NERR outreach activities.

members, as haku (ambassadors) for the He‘eia NERR.	
Strategy 9(c): Implement an assessment of He‘eia NERR facility needs.	He‘eia NERR has a plan that allows sufficient infrastructure and facilities to support research, education and stewardship programmatic activities.
Strategy 9(d): Recruit and hire a reserve manager to coordinate and supervise He‘eia NERR operations and management.	The He‘eia NERR management plan is implemented and core partnerships are established.
Strategy 9(e): The reserve manager will form and engage a Reserve Advisory Board (RAB) to gather advisory guidance on He‘eia NERR activities and planning.	Within the first year, the RAB is established and sets its meeting and committee structures.
Strategy 9(f): Establish and maintain He‘eia NERR website.	Increased understanding of ecological and cultural significance of the He‘eia estuary.
Strategy 9(g): Engage in the NERR national system and at relevant state, regional, national, and international scales.	Communities and individuals gain an understanding of the ecological and cultural significance of the He‘eia estuary.
Strategy 9(h): Plan for future He‘eia NERR facilities that integrate climate adaptation strategies and incorporate traditional Hawaiian values and customs.	He‘eia NERR facilities are resilient to a changing climate and embody the unique relationship between the Hawaiian people and the land.

Objective 10	
Support restoration of key areas in the He‘eia NERR to improve habitat and increase ecosystem services.	
Strategies to Meet Objective 10	**Outcomes**
Strategy 10(a): Demonstrate restoration best practices in the land and estuarine stewardship of He‘eia NERR natural resources that support climate change adaptation.	He‘eia NERR natural resource are more resilient to a changing climate.

Strategy 10(b): Revise land acquisition and habitat restoration projects, taking into account climate change impacts.	By 2018, land acquisition and habitat restoration plans are revised to incorporate climate vulnerabilities.
Strategy 10(c): He‘eia NERR uses a multi-disciplinary and multi- sector approach in the implementation of restoration initiatives.	He‘eia NERR is viewed as an example of multi-disciplinary and traditional approaches to ecosystem-based management.
Strategy 10(d): Work with partners to develop and implement a hybrid ecosystem framework for upland reforestation.	Measured improvements of targeted ecosystem services provided by upland habitat.
Strategy 10(e): Provide technical and monitoring assistance to support the removal of mangrove habitat and replacement with native estuarine species.	Measured improvements of targeted ecosystem services provided by estuarine habitat.
Strategy 10(f): Develop a restoration and monitoring plan in collaboration with partners to guide the restoration of the He‘eia Stream and adjacent buffer.	Restoration and monitoring plan guides future stream restoration and monitoring.
Strategy 10(g): Provide technical assistance and support for the removal of invasive species and the establishment native plant communities within the Heeia stream buffer and stream channels.	Measured improvements of targeted ecosystem services provided by the He‘eia stream and riparian habitats.
Strategy 10(h): Collaborate with partners on existing coral reef restoration and monitoring initiatives that are occuring within the marine boundaries of the He‘eia NERR.	Measured improvements of targeted ecosystem services provided by marine habitat.
Strategy 10(i): Coordinate future restoration planning and monitoring activities within marine boundaries of the He‘eia NERR.	Partners actively coordinate their marine restoration with He‘eia NERR staff.

Section 5. Administrative Plan

The administration plan describes the context of the state and federal agencies under which the NERRS is managed, as well as the state agency administrative and management structure for the He‘eia NERR (Figure 5-1). The administrative plan also describes the roles and responsibilities of the He‘eia NERR’s core staff and additional staff, reserve advisory board (RAB), identifies strategic partners, and community support groups. During the initial five years, it is anticipated that some expertise needs of the He‘eia NERR will be met with part-time hires, interns and strategic partners, as well as project volunteers. The administration-related objectives and strategies identified in the He‘eia NERR Strategic Plan are as follows.

He’eia NERR Administrative Objectives and Strategies

Administrative Objectives	Strategies
Objective 1: Baseline environmental data informs researchers' understanding of the magnitude of changes in the various He‘eia ecosystems.	**Strategy 1(k):** Recruit and maintain He‘eia NERR research and monitoring staff.
Objective 2: Coordinate independent research and monitoring efforts in the ahupua‘a.	**Strategy 2(d):** Recruit and maintain He‘eia NERR research and monitoring staff.
	Strategy 2(e): Collaborate with new partners conducting relevant research and monitoring efforts
Objective 3: Integrate traditional knowledge and research in the He‘eia NERR that will better reflect and inform community decision making toward creating a sustainable ecosystem.	**Strategy 3(c):** Work with site partners to share ecosystem-based best management practices that support improved management of the He‘eia ahupua‘a.
	Strategy 3(e): Recruit and maintain He‘eia NERR educational and cultural staff.
Objective 4: Increase student, educator, and community understanding of estuaries in general and in particular Hawaiian estuaries, coastal habitats, and the ahupua‘a land management system.	**Strategy 4(i):** Recruit and maintain He‘eia NERR educational, stewardship and cultural resource staff.
	Strategy 4(j): Establish and maintain He‘eia NERR website.

Objective 5: Provide a comprehensive framework to integrate and enhance coordination and effectiveness of place-based education and training programs that have been initiated independently by the He‘eia community.	**Strategy 5(c):** Develop initiatives that allow the He‘eia NERR and site partners to coordinate and integrate aspects of their educational activities.
Objective 6: Integrate traditional knowledge and contemporary science to effectively address climate change, habitat restoration, and water quality.	**Strategy 6(d):** Provide technical assistance to site partners in support of ongoing traditional agricultural (taro lo‘i) and aquaculture (He‘eia Fishpond) practices.
Objective 8: Become a leading repository of information for cultural, biological, and natural resources in the He‘eia estuary.	**Strategy 8(a):** Organize and incorporate cultural and natural resource information from the broader community into the He‘eia NERR website and other accessible platforms.
Objective 9: Develop the tools, capacity and connections to increase public awareness across the community, island, state, nation, and the world of the ecological and cultural significance of the He‘eia estuary and ultimately the entire ahupua‘a of He‘eia.	**Strategy 9(d):** Recruit and hire a Reserve Manager to coordinate and supervise He‘eia NERR operations and management.
	Strategy 9(e): The Reserve Manager will form and engage a Reserve Advisory Board (RAB) to gather advisory guidance on He‘eia NERR activities and planning.
	Strategy 9(f): Establish and maintain He‘eia NERR website.
	Strategy 9(g): Engage in the NERR national system and at relevant state, regional, national, and international scales.
Objective 10: Support restoration of key areas in the He‘eia NERR to improve habitat and increase ecosystem services.	**Strategy 10(e):** Provide technical and monitoring assistance to support the removal of mangrove habitat and replacement with native estuarine species.
	Strategy 10(g): Provide technical assistance and support for the removal of invasive species and the establishment native plant communities within the He‘eia Stream buffer and stream channels.

5.1 The He‘eia NERR Operational Guiding Principles

- The He‘eia NERR will strengthen its relationship with NOAA;
- The He‘eia NERR will strengthen its relationship with OP-CZM;

- The He‘eia NERR will ensure its operating infrastructure is adequate to fulfill its mission;
- The He‘eia NERR will ensure that it has sufficient staff to meet its goals and objectives;
- The He‘eia NERR will ensure that its staff has the skills necessary to perform their duties and responsibilities;
- The He‘eia NERR staff will have a thorough understanding of the ahupua‘a principles and an understanding of the ahupua‘a of He’eia;
- The community and other government agencies will recognize the He‘eia NERR as a source of relevant and current information on the He‘eia estuary and ahupua‘a;
- The He‘eia NERR staff will be fully engaged to seek funding opportunities to meet its goals and objectives.

5.2 Organizational Framework and Management Authorities

The NERRs in the national system operate as federal/state partnerships. The State of Hawai‘i, through UH’s HIMB, will manage the operation of the He‘eia NERR, while the federal government, represented by NOAA, will provide funding, national guidance, and technical assistance. The roles and responsibilities of the University and NOAA in operating the He‘eia NERR are laid out in a Memorandum of Understanding (Appendix J). The various landowners in the He‘eia NERR also have a major role to play in implementing the goals, objectives and strategies developed in this management plan. How the various partners interact with HIMB as the lead state partner for the He‘eia NERR, and with each other, is laid out in an additional Multi-Party Governance Charter between the land owners within the He‘eia NERR (Appendix K). The agreement is entered between UH and the various land owners whose property has been voluntarily included in the He‘eia NERR and where research, education, training and stewardship activities will take place.

The state role in the NERR program includes providing 30% matching funds for NERR program grants, demonstrating adequate control over nonfederal lands included in the He‘eia NERR (either through ownership or cooperative agreement with private landowners), providing adequate staffing for the He‘eia NERR, and overseeing program implementation. Because the He‘eia NERR contains a mix of private and state lands, responsibility for land management actions, including manipulation and restoration activities, will remain with the governmental agency and/or private landowner that has statutory or legal authority.

The federal role in the NERR program includes providing NERR program grants, subject to appropriations, coordinating between the national system and local programs, and supplying technical assistance for NERR program implementation. Also, pursuant to CZMA (Sections 312 and 315), NOAA periodically conducts performance evaluations of the operation and management of reserves.

HIMB will manage the day-to-day operations of the He‘eia NERR. The He‘eia NERR will be considered an operational unit under HIMB, and He‘eia NERR staff will report to and will be accountable to HIMB leadership. HIMB is administratively located within the School of Ocean and Earth Science and Technology (SOEST) at UH. SOEST and UH will provide administrative, financial, and human resources (personnel) support under applicable state and UH policies and procedures. HIMB will provide overall program direction and guidance and assist with day-to-day administration and coordination within SOEST’s and UH’s organizational structure. HIMB and UH administrative staff will provide assistance with financial and personnel management, purchasing, logistics, and community interaction. Initially, five dedicated positions are suggested to provide overall management of the He‘eia NERR and implement He‘eia NERR programs for research, education, and stewardship, as described in the next section.

Currently, each NERR receives an average federal funding allocation of $550,000 (made available to NERR sites under CZMA Section 315). Establishing state-funded positions in UH’s HIMB budget will provide the 30% match requirement for the federal grant. Additional support may include salaries from state funded personnel performing work or research within the He‘eia NERR, an in-kind match of volunteer labor, or materials provided by community organizations or site partners, additional funding for the He‘eia NERR from the state legislature (via various partner agency budgets), and state or private grant awards.

5.3 He‘eia NERR Staff and Future Needs

The State of Hawai‘i will provide staff position lines to HIMB for the He‘eia NERR to meet its goals and objectives as outlined in this management plan. Core staff as required by NOAA will consist of a Reserve Manager, Research Coordinator, and Education Coordinator. Two additional roles necessary for the He‘eia NERR include a Stewardship Coordinator who will coordinate with the partners in the He‘eia NERR, and a Cultural Resource Coordinator who will ensure activities taking place within the He‘eia NERR are conducted in a culturally appropriate manner as well as give a cultural, place-based perspective to He‘eia NERR programs. The He‘eia NERR staff will report to HIMB leadership and will be hired by HIMB following UH personnel hiring policies and procedures.

To meet the initial staffing and program needs, at least five staff positions will be sought (Reserve Manager, Research Coordinator, Education Coordinator, Stewardship Coordinator, Cultural Resource Coordinator) to augment the current UH budget, the salaries of which will be covered by state general funds, during the appropriate State legislative session. If approved, these positions will be available once the He‘eia NERR has been designated. Cost-sharing with partner organizations is another staffing option. Additional positions, as outlined in section 5.3.6 below, may be created as the program grows and resources become available. The roles and responsibilities of the staff positions are described below.

5.3.1 Reserve Manager

The Reserve Manager will coordinate and supervise all aspects of He‘eia NERR operations and management, including administrative, funding, research, stewardship, training, and educational activities. The Reserve Manager will serve as a liaison between federal, state, and local government agencies, the community, and private entities, including advisory committees or boards, to achieve the goals and objectives of the He‘eia NERR. The Reserve Manager will also be the principal point of contact for outside agencies. The Reserve Manager will be an HIMB employee and will report to HIMB leadership.

5.3.2 Research Coordinator

The Research Coordinator will oversee the operation and implementation of the He‘eia NERR research and monitoring program, coordinate site partner research programs, interpret research results, promote the use of the He‘eia NERR by other researchers, and interact with other research institutions and individuals to fulfill the research goals and objectives of the He‘eia NERR. The Research Coordinator will work to collaborate with site partners and other coordinators of the He‘eia NERR to develop and present scientific information in a user-friendly manner. The Research Coordinator will develop and initially implement the System Wide Monitoring Program (SWMP) which will help to support and inform research as it is conducted in the He‘eia NERR. The Research Coordinator will be an HIMB employee and will report to the Reserve Manager.

5.3.3 Education Coordinator

The Education Coordinator will oversee the daily operation and implementation of the He‘eia NERR education programs, including on-site and outreach activities. The Education Coordinator will interact with other environmental education organizations and individuals, other sectors of the He‘eia NERR, and other coordinators of the He‘eia NERR to fulfill educational goals and objectives and to present science and stewardship information in a user-friendly manner to schools and the public. These activities will include formal and informal education for the public, teachers, and students. The Education Coordinator will develop and implement the Coastal Training Program for local decision-makers and resource professionals. The Education Coordinator will be an HIMB employee and will report to the Reserve Manager.

5.3.4 Stewardship Coordinator

The Stewardship Coordinator will oversee the resource management activities in the He‘eia NERR, including restoration and manipulation activities. The Stewardship Coordinator will cooperate with land managers and other coordinators of the He‘eia NERR to enhance public awareness and understanding of the estuary and the resource management activities taking place in the He‘eia NERR. The Stewardship Coordinator will be an HIMB employee and will report to the Reserve Manager.

5.3.5 Cultural Resource Coordinator

The Cultural Resource Coordinator will be critical in convening the cultural partners and ensuring that the goals and objectives in this management plan related to the cultural components are implemented in a culturally responsible and sensitive manner. The Cultural Resources Coordinator will cooperate with other coordinators of the He‘eia NERR to support the education, research, and stewardship programs by giving a place-based, cultural perspective to these activities. The Cultural Resource Coordinator will focus on cultural aspects of coastal issues including endemic, native and naturalized species management, integrating traditional knowledge with scientific research on resource management techniques, and the interconnectedness of the ecosystems within the ahupua‘a. The Cultural Resource Coordinator will be an HIMB employee and will report to the Reserve Manager.

5.3.6 Additional Staff

Once the He‘eia NERR is established and program activities are established, additional staffing or expertise may enhance the effectiveness of the activities outlined in this management plan. It is anticipated that the positions will be provided by a combination of full-time or part-time hires, interns and strategic partnerships, as well as volunteers. Based on the management plan’s goals and objectives, the following positions will likely be needed:

- Administrative Assistant: Support the He‘eia NERR manager including clerical, grant management, and operational support to He‘eia NERR activities.
- Coastal Training Coordinator: Oversee the continued implementation of the Coastal Training Program for local decision-makers and resource professionals to support the goals and objectives of the He‘eia NERR, especially supporting the monitoring of ecosystem services provided by management strategies in the He‘eia NERR.
- Technical Assistant for the System Wide Monitoring Program (SWMP): Maintain SWMP equipment, collect samples for water quality and nutrient monitoring, troubleshoot problems and compile and submit data to the NERRS Centralized Data Management Office, as well as assist with He‘eia NERR research and education programs, especially supporting the monitoring of ecosystem services provided by management strategies in the He‘eia NERR.
- Geographic Information Systems (GIS) Technician: Utilize GIS technology to support He‘eia NERR activities, including map-making, land cover and land use analysis, ground-truthing for research projects, field work, and resource management.
- Research Analyst: Analyze data and assist with research projects and monitoring of ecosystem services provided by management strategies in the He‘eia NERR, in support of the primary research question of the He‘eia NERR.

- Watershed Specialist: Coordinate with additional watershed partnerships and organizations within the He‘eia and surrounding watersheds, ensuring He‘eia NERR activities are informed by nearby developments in the watershed.

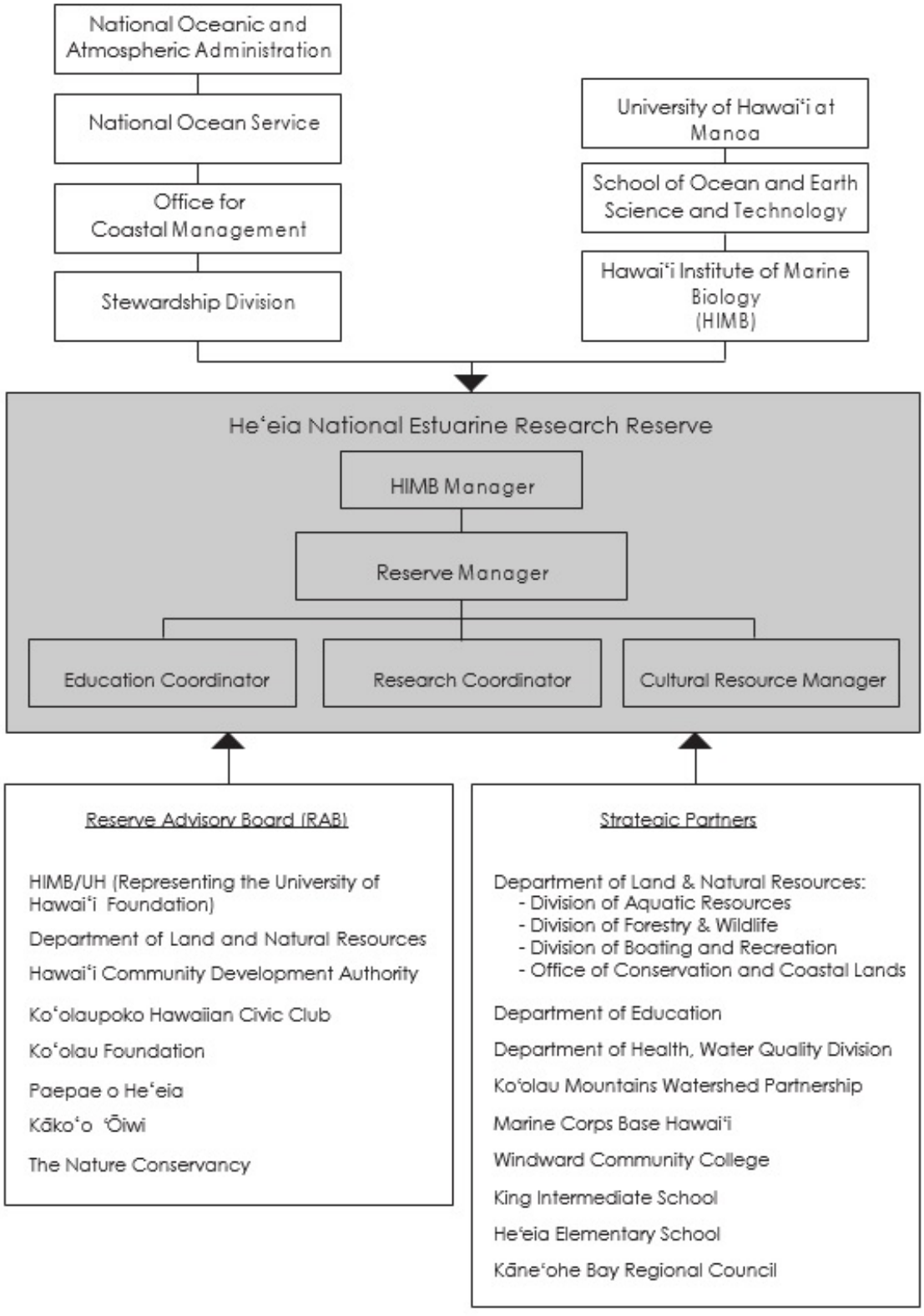

Figure 5.1. He'eia NERR administrative organization chart

5.4 Strategic Partnerships

The successful implementation of a NERR management plan occurs through a collaborative process involving a variety of agencies, organizations, and community partners at various levels of participation and contribution. Strategic partnerships are needed to leverage specific resources and talent to carry out core functions of the He‘eia NERR and assist with stewardship, educational programs, research, and operations. The following list identifies some of the key partnerships that will support the mission of the He‘eia NERR along with HIMB and He‘eia NERR staff. These partners could provide in-kind staffing, expertise and resources, financial resources, facilities, etc. These partners include:

- Ko‘olaupoko Hawaiian Civic Club
- Ko‘olau Foundation
- Kāko‘o ‘Ōiwi
- Paepae o He‘eia
- Department of Land and Natural Resources
    - Division of Aquatic Resources
    - Division of Forestry and Wildlife
    - Division of Boating and Ocean Recreation
    - Office of Conservation and Coastal Lands
    - State Historic Preservation Division
- Hawai‘i Community Development Authority
- Kamehameha Schools
- The Nature Conservancy
- Kama‘āina Kids
- Department of Education
- Department of Health, Clean Water Branch
- Kāne‘ohe Bay Regional Council
- Ko‘olau Mountains Watershed Partnership
- Marine Corps Base Hawai‘i
- Windward Community College
- King Intermediate School

- He‘eia Elementary School

The roles and functions of these partners in relation to the He‘eia NERR will be developed and expanded as the specific needs for support emerge and change during the implementation of the He‘eia NERR management plan. New partnerships can be created as opportunities arise.

5.5 Advisory Committees

5.5.1 Reserve Advisory Board

The policies, activities, and programs of the He‘eia NERR will be developed and implemented with input from the Reserve Advisory Board (RAB). Land for the He‘eia NERR is owned in part by the UH Foundation (Moku o Lo‘e), Kamehameha Schools (He‘eia Fishpond), HCDA (He‘eia CDD), and DLNR (He‘eia State Park and Kāne‘ohe Bay waters). The RAB will be created upon designation of the He‘eia NERR by NOAA and its members will adopt the Multi-Party Governance Charter (Appendix K).

Members of the RAB include:

- Hawai‘i Institute of Marine Biology (Representing the UH Foundation)
- Department of Land and Natural Resources
- Hawai‘i Community Development Authority
- Paepae o He‘eia
- Ko‘olaupoko Hawaiian Civic Club
- Ko‘olau Foundation
- Kāko‘o ‘Ōiwi
- The Nature Conservancy

The RAB will advise HIMB and He‘eia NERR staff on management, research and monitoring activities, educational programs, and stewardship activities based on the approved management plan. The RAB will also help enable the development and maintenance of partnerships and cooperative efforts with the community; local, state, and federal agencies; and other research and educational institutions. The RAB, once formed, will set its meeting structure and membership provisions, create committees or subcommittees as necessary to gather technical information or community input, and establish specific roles and responsibilities to best support the implementation of the management plan. See the Multi-Party Governance Charter (Appendix K) for more details on the role of the RAB.

5.5.2 Other Committees

The He‘eia NERR Reserve Manager, in coordination with the RAB, will be able to create committees or subcommittees as necessary to gather technical information or community input to implement the

management plan. Advisory committees may be particularly useful in the early stages of developing He‘eia NERR programs; they can be used to solicit input on community priorities, garner support and resources, and recruit additional He‘eia NERR program staff to implement programs. Some potential program advisory committees are described below.

Kūpuna Advisory Committee

The He‘eia NERR Reserve Manager and RAB may establish a Kūpuna Advisory Committee to provide cultural guidance to the Board on cultural protocols, Native Hawaiian traditional and customary practices either within the He‘eia NERR or within the ahupua‘a of He‘eia, or any other relevant and appropriate cultural information. The Kūpuna Advisory Committee shall be composed of Kūpuna or cultural practitioners familiar with the ahupua‘a of He‘eia or its cultural resources.

Research Advisory Committee

The He‘eia NERR Reserve Manager and RAB may establish a research advisory committee to coordinate and provide input on the He‘eia NERR’s research and monitoring program. This group will be chaired by the He‘eia NERR Research Coordinator and be composed of research staff from the RAB, federal and state agency staff, and visiting researchers who have an interest in the He‘eia NERR research program.

Education Advisory Committee

The He‘eia NERR Reserve Manager and RAB may establish an education advisory committee to coordinate and provide input on the He‘eia NERR’s education programs. This group will be chaired by the He‘eia NERR Education Coordinator and be composed of education staff from the RAB; federal and state agency staff; teachers and administrators representing a variety of levels, geographic areas, and subjects; and visiting educators who have an interest in the He‘eia NERR education program. The group can provide community input and planning support for developing and implementing NERRS education programs such as TOTE and KEEP. Cultural educators may also sit on the education advisory committee to ensure cultural aspects are considered in developing education programs at the He‘eia NERR.

Cultural Resource Committee

The He‘eia NERR Reserve Manager and RAB may establish a cultural resource committee to coordinate and provide input on cultural aspects of He‘eia NERR programs. The group will be co-chaired by the He‘eia NERR Cultural Resource Coordinator and He‘eia NERR Stewardship Coordinator, and be composed of members from the RAB, cultural practitioners, and those whose families have lineal and cultural connections to the ahupua‘a of He‘eia, as well as cultural educators.

Section 6. Resource Protection Plan

This plan will support the resource protection-related objectives and strategies listed below and identified in the He‘eia NERR Strategic Plan.

He‘eia NERR Resource Protection-Related Objectives and Strategies

Objective 1: Baseline environmental data informs researchers’ understanding of the magnitude of changes in the various He‘eia ecosystems.	**Strategy 1(g):** Conduct scientific research and monitoring that will provide information on climate change, water quality, estuary habitat change, and other topics of local and national interest and significance.
Objective 7: Engage and educate the community on the practices and values of the ahupua‘a land management system; in other words, promote ‘āina momona and enhanced stewardship efforts by all sectors of the community, to increase their understanding of how human activities and natural events affect the estuary.	**Strategy 7(b):** Collaborate with partners to incorporate He‘eia NERR science, traditional knowledge and information in the rehabilitation of historical, agricultural and aquacultural resources within the He‘eia NERR.
Objective 10: Support restoration of key areas in the He‘eia NERR to improve habitat and increase ecosystem services.	**Strategy 10(c):** He‘eia NERR uses a multi-disciplinary and multi- sector approach in the implementation of restoration initiatives.

The resource protection plan is a required element of a reserve management plan, per 15 CFR 921.13. The general provisions provided by 15 CFR 921.1 state that reserves shall be open to the public to the extent allowed by state and federal law, and multiple uses are allowed to the degree that they are compatible with reserve purpose and use levels prescribed in the management plan. Additionally, regulations note that the management plan shall identify uses requiring a state permit, as well as areas where uses are encouraged or prohibited. Protecting the resources of the reserve serves as the foundation for all programmatic efforts and is central to the success of the reserve. It is important for reserves to protect the ecological unit representative of key lands and waters in each biogeographic region and to maintain it in the face of human and natural stressors that are continually increasing.

This management plan's resource protection plan provides a description of the authorities that protect the He'eia NERR, allowable and unallowable uses per those authorities, uses requiring a permit, and the initial monitoring, surveillance, and enforcement strategies that will be employed to protect resources in the He'eia NERR. The authorities detailed in the management plan are the existing authorities that are in place to protect the He'eia NERR. Designating the He'eia NERR does not add new regulations or restrictions on uses or activities within the He'eia NERR. The currently existing regulations are enforced within the capabilities of the federal, state, and county enforcement authorities as assisted by a supportive community. Supporting those efforts, and building close working relationships with enforcement entities and the community to help protect the resources will be essential to meet the protection goals and objectives of the He'eia NERR.

6.1 Resource Protection Challenges

Maintaining adequate control of reserve resources can be challenging. External stressors that may affect or degrade resources in the He'eia NERR include discharges of contaminants from the surrounding urban area, erosion, degradation of the watershed and streams caused by invasive plants and animals, loss of biodiversity, introduction of new harmful invasive species or diseases, unsustainable commercial and public recreational uses, overfishing, and changing climatic conditions.

Based upon community input and preliminary research, the major resource protection challenges facing the He'eia NERR in the next 5 years are:

- degradation of water quality and coral reefs from land-based erosion and pollutants,
- introduction and spread of invasive species and diseases,
- climate change, and the loss of ecosystem resilience,
- damage to coral reefs and fish stocks from consumptive and nonconsumptive commercial and recreational uses, and
- vandalism, theft, or destruction of natural and cultural resources, facilities, and agricultural products.

6.2 Reserve Protection Strategy

The He'eia NERR consists of a mix of public and private properties with established authorities specific to each of the landowners. These authorities, when applied together, serve to protect the natural and cultural resources of the area and promote a stable environment for research, monitoring, education, training, and stewardship programs that address local coastal management issues. The reserve protection strategy is divided into two elements: monitoring of the existing condition of the resources, which allows authorities

to identify and prevent harmful impacts on the integrity of the ecosystem, and surveillance and enforcement of unauthorized or harmful activities that may affect the integrity of the He‘eia NERR.

The monitoring element of the reserve protection strategy is embodied by the He‘eia NERR’s research and monitoring program (see Section 4.1). The goal and objectives of the research and monitoring program include strategies to develop a comprehensive, long-term, baseline environmental monitoring program to understand the effects of human manipulation and restoration activities, climate change and natural events on the ecosystem services provided by the area. This program will provide information to track trends in resource health and conditions and detect any deleterious effects such as increased erosion, import of pesticides or other toxicants harmful to species and habitats, introduction of diseases or invasive species harmful to native ecosystems, die-offs of native species such as large mortality events from coral bleaching or coral diseases, and declines in ecosystem services or degradation of species, habitats, or cultural resources essential to the systems of the He‘eia NERR. If deleterious effects are detected, prevention, minimization, and mitigation measures can be implemented to protect or prevent impacts on resources and, if associated with land management activities, practices can be adapted to avoid impacts in the future.

6.3 Surveillance and Enforcement

The He‘eia NERR has no law enforcement jurisdiction and relies on the enforcement authorities of DLNR, USFWS, NOAA, and City and County of Honolulu police to enforce regulations pertaining to public safety, building, traffic, littering, dumping, hunting, fishing, boating, commercial use of public lands, research, and take of protected species. Many of these activities may require county, state, or federal permits or approvals. Use of all lands in the He‘eia NERR will require the permission of the landowners or their agents and be subject to conditions imposed by the land owner or their agents. No He‘eia NERR restrictions or use restraints will be imposed on outside researchers conducting studies on public lands or in public waters. Research permits may be required by DLNR, USFWS, and/or NOAA for destructive sampling and collecting of plants or vertebrates on public or private lands. The He‘eia NERR does not create any new permitting requirements; existing permitting requirements would still apply within the He‘eia NERR. Violations of permits and conditions will be subject to the sanctions and penalties provided by City and County of Honolulu, DLNR, USFWS, and NOAA, as the issuing authorities.

The Reserve Manager will be the day-to-day liaison with the county, state, and federal law enforcement authorities. All He‘eia NERR staff, site partners, and employees will be aware of the rules and regulations regarding allowable uses within the He‘eia NERR, and will be on the lookout for any violations or enforcement problems in the area. If observed, violations will be reported to the Reserve Manager and proper authorities. The Research Coordinator will be responsible for tracking research activities and will be aware of any research permit requirements to provide guidance and assistance to researchers.

The community members and strategic partners that are often present in the He‘eia NERR, participating in education and research programs or enjoying recreational opportunities, have a role to play in protecting the He‘eia NERR as well. They are often the eyes and ears that see and hear activities that are not allowed or could damage resources and that should be stopped or investigated. The community is therefore encouraged to look out for potential problems, and to contact the Reserve Manager and law enforcement authorities to report suspected rule violations or harmful actions. DLNR has organized community enforcement support groups such as the Makai Watch in communities across the state; the RAB and Reserve Manager will evaluate the need for establishing a Makai Watch or similar group for the He‘eia NERR, and if such a group is deemed necessary for the area, will provide the necessary administrative and logistical support for establishing it.

Management authorities, rules, and regulations; allowable and unallowable uses; and law enforcement entities and partnerships that protect the He‘eia NERR are discussed in the following subsections.

6.4 Management Authorities and Law Enforcement Partners

6.4.1 Federal Regulatory Agencies, Management Authorities, and Enforcement Entities

NOAA’s Office of Law Enforcement

NOAA’s Office of Law Enforcement protects marine wildlife and habitat by enforcing domestic laws and international treaty requirements designed to ensure that these global resources are available for future generations. The Office’s special agents and enforcement officers ensure compliance with the nation’s marine resource laws and take enforcement action when these laws are violated. NOAA has law enforcement personnel stationed on O‘ahu, who are available to investigate and respond to federal ocean resource enforcement violations (NOAA Office of Law Enforcement 2015).

NOAA National Marine Fisheries Service (NMFS)

NMFS has regulatory responsibility for identifying essential fish habitats for federally regulated species of fishes, and carrying out provisions of the Magnuson-Stevens Act, the Endangered Species Act, and the Marine Mammal Protection Act. NMFS also provides input to the U.S. Army Corps of Engineers (USACE) on wetland permits issued under the CWA. NMFS’s Protected Resources Division (PRD) is dedicated to protecting and recovering endangered and threatened species of sea turtles, monk seals, and cetaceans and strives to ensure the recovery and survival of the protected marine species. NMFS and the PRD have personnel stationed on O‘ahu who respond to reports of live and dead stranded or distressed marine mammals in the main Hawaiian Islands. These personnel can assist with responses to diseases and other threats to protected marine species in the He‘eia NERR (NMFS PIRO 2015).

U.S. Fish and Wildlife Service (USFWS)

USFWS has regulatory authority over effects on endangered species and migratory birds as they relate to the He‘eia NERR, and is a potential partner in funding restoration activities. USFWS also makes recommendations to USACE regarding wetland permits. USFWS has enforcement personnel stationed on O‘ahu, who are available to investigate and respond to federal violations. USFWS refuge and ecological services staff also are stationed on O‘ahu; these staff members can assist with responses to diseases and other threats to protected species, such as by investigating disease outbreaks and helping with containment and recovery (USFWS PIFWO 2015).

U.S. Environmental Protection Agency (EPA)

EPA works with its federal, state and tribal regulatory partners to monitor and ensure compliance with clean water laws and regulations in order to protect human health and the environment. Section 404 of the CWA regulates the placement of dredged or fill material into wetlands, streams, estuaries and other waters. The goal of Section 404 is to avoid and minimize losses to wetlands and other waters and to compensate for unavoidable loss through mitigation and restoration. Section 404 is jointly implemented by EPA and the USACE. The USACE issues Section 404 permits and monitors compliance with the issued permits. Both the USACE and EPA are responsible for on-site investigations and enforcement of unpermitted discharges under CWA Section 404 (EPA 2015). EPA also shares permitting and enforcement authority for federal wetlands with the HIDOH, CWB, who administer the Section 401 Water Quality Certification Program in Hawai‘i (HIDOH CWB 2015). A Section 401 water quality certification is required for EPA and USACE to issue a wetland fill permit (EPA 2015).

U.S. Army Corps of Engineers (USACE)

USACE is responsible for administration of the federal wetland permitting program for the tidal and nontidal wetlands in the He‘eia NERR and adjacent waters and wetlands. The USACE’s Regulatory Program is committed to protecting the Nation’s aquatic resources, while allowing reasonable development through fair, flexible and balanced permit decisions. The Corps evaluates permit applications for essentially all construction activities that occur in the Nation’s waters, including wetlands. The local USACE regulatory office is the Honolulu District office located at Fort Shafter on O‘ahu (USACE 2015).

6.4.2 State Regulatory Agencies, Management Authorities, and Enforcement Entities

DLNR Division of Conservation and Resources Enforcement (DOCARE)

DOCARE is responsible for the enforcement activities of the DLNR. The division, with full police powers, enforces all state laws and rules involving state lands, state parks, historic sites, forest reserves, aquatic life and wildlife areas, coastal zones, conservation districts, and state shores, as well as county ordinances involving county parks. The division also enforces laws relating to firearms, ammunition, and dangerous weapons (DLNR 2015).

One of DOCARE's community-based assistance programs is the DLNR Makai Watch Volunteer Program. The Makai Watch is an officially recognized DLNR program to create more effective management of Hawai'i's near-shore marine resources (DOCARE 2015). The program is a voluntary, community-based partnership that involves volunteers and nongovernmental organizations such as The Nature Conservancy (TNC), Kua'āina Ulu 'Auamo, (KUA), the Hawai'i Wildlife Fund (HWF), Project S.E.A.-Link, Conservation International (CI) Hawai'i and the Harold K. Castle Foundation. Makai Watch volunteers assist DLNR by acting as the 'eyes and ears' of conservation enforcement in the community. The program trains volunteers on observation and incident reporting, ocean awareness and outreach, common regulated species found in Makai Watch areas, and traditional and modern ocean management tools. Trainees also learn to practice cultural awareness when engaging with resource users, providing for more positive interactions with local families and fishers.

DLNR Division of State Parks

The DLNR Division of State Parks manages and administers 52 state parks encompassing nearly 25,000 acres on the state's five major islands. These parks offer varied outdoor recreation and heritage appreciation opportunities. The park environments range from landscaped grounds with developed facilities to wildland areas with trails and primitive facilities. The Division also issues camping permits. (DLNR 2015)

DLNR Division of Aquatic Resources (DAR)

The DLNR Division of Aquatic Resources (DAR) manages and regulates the state's marine and freshwater resources through programs in commercial fisheries and aquaculture; aquatic resource protection, enhancement, and education; and recreational fisheries. Major program areas include projects to maximize commercial fishery and aquaculture productivity, protect native and resident aquatic species and their habitats, and provide facilities and opportunities for recreational fishing consistent with the interests of the state. DAR also issues fishing licenses. (DLNR 2015)

DLNR Division of Boating and Ocean Recreation (DOBOR)

DOBOR is responsible for the management, administration, and regulation of statewide ocean recreation and coastal area programs pertaining to the ocean waters and navigable streams of the state (exclusive of commercial harbors), which includes 21 small boat harbors (such as He‘eia Kea Small Boat Harbor), 54 launching ramps, 13 offshore mooring areas, 10 designated ocean water areas, 108 designated Ocean Recreation Management Areas (ORMAs), associated aids to navigation throughout the state, and beaches encumbered with easements in favor of the public. DOBOR is also responsible for the registration of small vessels. (DLNR 2015)

DLNR Division of Forestry and Wildlife (DOFAW)

DOFAW is responsible for the management of state-owned forests, natural areas, public hunting areas, and plant and wildlife sanctuaries. Program areas include watershed protection; native resources protection, including unique ecosystems and endangered species of plants and wildlife; outdoor recreation; and commercial forestry. DOFAW also issues hunting permits. (DLNR 2015)

DLNR Office of Conservation and Coastal Lands (OCCL)

OCCL is responsible for overseeing approximately 2 million acres of private and public lands that lie within the State Land Use Conservation District. In addition to overseeing privately and publicly zoned Conservation District lands, OCCL is responsible for overseeing beach and marine lands out to the seaward extend of the state’s jurisdiction. (DLNR 2015)

DLNR State Historic Preservation Division (SHPD)

SHPD works to preserve and protect historic and cultural resources which link the past to the present. SHPD’s three branches: History and Culture, Archaeology, and Architecture, strive to accomplish this goal through a number of different activities. The SHPD’s statewide Inventory of Historic Properties contains information on more than 38,000 historic sites in Hawai‘i. Reviews of development projects are SHPD’s primary means of lessening the effects of change on historical and cultural assets.

The Burial Sites Program, the Certified Local Government Program, the Historic Preserves Program, maintenance of the Hawai‘i and National Register of Historic Places, SHPD’s Information and Education Program, and Inter-agency Archaeological Services are designed to promote the use and maintenance of historical properties for the education, inspiration, pleasure, and enrichment of Hawai‘i’s citizens and visitors (SHPD 2015).

DOH-Clean Water Branch (CWB)

The Department of Health (DOH) Clean Water Branch (CWB) is part of the Department's Environmental Management Division (EMD) which administers the State's surface water and groundwater quality assessment, management, permitting, and enforcement programs. The CWB, through its Polluted Runoff Control Program, develops and manages the state's nonpoint source (NPS) management program pursuant to Section 319 of the Clean Water Act (CWA). The other sections in the CWB include the monitoring and analysis, engineering, and enforcement and compliance sections. These sections monitor water quality, prepare integrated reports every two years (pursuant to Sections 305(b) and 303(d) of the CWA), administer and enforce the NPDES permit program for point source discharges and issue and regulate CWA Section 401 water quality certifications (DOH CWB 2015).

Hawai‘i Community Development Authority (HCDA)

The HCDA is a State agency that was established to supplement traditional community renewal methods by promoting and coordinating public and private sector community development. In 1991, HCDA acquired the 405-acre He'eia wetlands in a land exchange agreement. In 2011, HCDA gained official redevelopment responsibility over the He'eia Wetlands when the State Legislature created the He'eia Community Development District (CDD) under HRS § 206E-202. The He'eia Community Development District was established to facilitate cultural practices, culturally appropriate agriculture, education and natural resource restoration and management of the He‘eia wetlands. In 2010, the HCDA entered into a 38 year lease with Kāko‘o ‘Ōiwi to restore the He‘eia wetlands into a working agricultural and cultural district. In implementing the development district, HCDA was additionally charged to manage the area in alignment with the Honolulu Board of Water Supply's most current "Ko‘olaupoko Watershed Management Plan" and the City and County of Honolulu's most current "Ko‘olaupoko Sustainable Communities Plan" as well as consult with adjacent landowners, Ko‘olaupoko Hawaiian Civic Club, Kailua, Kahalu‘u and Kāne‘ohe neighborhood boards, to assist land users to manage their properties, work with federal, state, county and other agencies to ensure that infrastructural support is provided for the district, and provide opportunity for the restoration and implementation of sustainable, culturally appropriate, biologically responsible, or agriculturally beneficial enterprises.

‘Aha Moku Advisory Committee

The ‘Aha Moku Advisory Committee was established within the DLNR in 2012 to advise the chairperson of the Board of Land and Natural Resources on issues related to culture and land and natural resources management through the ‘aha moku system. The ‘aha moku system is a system of best practices based on indigenous resource management practices within specific moku boundaries to sustain resources and the community of that moku. These boundaries acknowledges the ahupua‘a and larger moku or districts of each island, the specific resources located within those areas, and the methodology necessary to sustain resources

and provide for the community. The ʻaha moku system fosters understanding and practical use of knowledge, including native Hawaiian methodology and expertise, to assure responsible stewardship and awareness of the interconnections of the clouds, forests, valleys, land, streams, fishponds and sea. The ʻaha moku system is based on native Hawaiian traditional knowledge that ensures a community consultation process focused on the health and welfare of natural and cultural resources in Hawaiʻi. Heʻeia is in the Moku of Koʻolaupoko and is represented by the Moku O Kakuhihewa (Oʻahu) on the advisory committee. The ʻAha Moku Advisory Committee will provide guidance for cultural and land management activities in the Heʻeia NERR. (DLNR 2015)

Kāneʻohe Bay Regional Council

The Kāneʻohe Bay Regional Council was established by HRS Chapter 200D to facilitate the implementation and periodic review of the Kāneʻohe Bay Master Plan. This plan mentions a NERR designation as a possible way that "Kāneʻohe Bay be recognized as a resource of local, national, and global significance, and that it be afforded, all or in part, protected area status with the primary goal being to attain effective management and conservation" (OP 1992). The council was also given the duties and functions to serve as a central coordinating clearing house of public and private activities in Kāneʻohe Bay, facilitate productive interaction between users of Kāneʻohe Bay and the general public, recommend research, studies, data collection and planning of activities designed to provide additional information on Kāneʻohe Bay, advise the State and County on matters regarding the use of Kāneʻohe Bay, and educate the public and users of Kāneʻohe Bay about problems and programs in the bay. One of the other important functions is to serve as a public advocate, initiate and maintain contact with public, private, county and state organizations, agencies and individuals engaged in activities in the bay, and establish a Kāneʻohe Bay fishing panel to monitor fishing activities in the Bay. The council is administratively established within the DLNR, chaired by the administrator of DAR, and meets quarterly. DAR is in the process of reinvigorating the council and scheduling regular meetings. The council will be a strategic partner to coordinate with the Heʻeia NERR and provide feedback on how programs and activities in the Heʻeia NERR affect other users in the Bay.

6.4.2.1 County Regulatory Agencies, Management Authorities, and Enforcement Entities

City and County of Honolulu, Honolulu Police Department (HPD)

HPD serves as the primary law enforcement agency for the entire island of Oʻahu (HPD 2013). The Chief of Police directs the operation and administration of the department and is responsible for preservation of the public peace, protection of the rights of persons and property, prevention of crime, detection and arrest of offenders against the law, enforcement and prevention of violations of state laws and city ordinances, and service of processes and notices in civil and criminal proceedings. The department's jurisdiction is the City and County of Honolulu. For police operations, the island is divided into eight patrol districts; each district is subdivided into sectors and beats. The department's

headquarters is in downtown Honolulu. A district station is found in Kāneʻohe near the He'eia NERR (HPD 2015).

All of the Heʻeia NERR is located entirely within the City and County of Honolulu, on Oʻahu. HPD provides routine local enforcement in the Heʻeia NERR, and the Honolulu Fire Department stationed in Kāneʻohe will provide fire protection and emergency response services. All applicable local ordinances and restrictions will be observed in the Heʻeia NERR. The site partners have good working relationships with county police and fire personnel, and those relationships are expected to continue after the Heʻeia NERR designation.

Department of Planning and Permitting (DPP)

DPP is responsible for the City and County of Honolulu's long-range planning, community planning efforts, administration and enforcement of ordinances and regulations governing the development and use of land, various codes pertaining to the construction of buildings, and city standards and regulations pertaining to infrastructure requirements. DPP oversees the protection and regulation of uses within the coastal Special Management Areas (SMA) on Oʻahu. Building and major resource disturbances require an SMA permit. Nearly the entire Heʻeia NERR is located in the SMA and its uses are thus regulated by the DPP (DPP 2015).

6.4.3 State Agency Statutes, Rules, and Regulations

The statutes, rules, and regulations that apply to resource conservation and management in the Heʻeia NERR are listed below by agency and topic. Additional descriptions on pertinent sections of each rule are provided in Appendix L.

Department of Land and Natural Resources

1. Kāneʻohe Bay Regional Council (HRS Chapter 200D)
2. ʻAha Moku Advisory Committee (HRS Chapter 171-4.5)

Office of Conservation and Coastal Lands

1. Conservation District (Title 13, Hawaiʻi Administrative Rules [HAR], Chapter 5)

Division of Aquatic Resources

1. Hawaiʻi State fishing regulations—General
    - Commercial bait license (HRS §188-45)
    - Commercial marine license (HRS §189-2.3)
    - Aquaculture license (HRS §187-3.5, HAR Chapter 13-74-43)

- Aquaculture facility license (HRS §187-3.5, HAR Chapter 13-74-43)
- Special activity permit (HRS §187A-6)
- Recreational bottomfish fishing vessel registration (HAR Chapter 13-94)
- Commercial fishing vessel registration (HAR Chapter 13-94)

2. Hawai‘i State fishing regulations—Site-specific
    - He‘eia Kea Wharf (HAR Chapter 13-188-36)
    - Coconut Island (HAR Chapter 13-188-36)
3. Fisheries resource management
    - Lay nets (HAR Chapter 13-75-12 (4))
    - O‘ahu aquarium life management (HAR Chapter 13-77-1)
4. Protected marine fisheries resources (HAR Chapters 13-83 to 95)
5. Protected freshwater fisheries resources (HAR Chapter 13-100)

Division of Boating and Ocean Recreation

1. Small boat harbors
    - Offshore Mooring Rules and Areas (HAR Chapter 13-235)
2. Boating [general] (HAR Chapters 13-240 to 245)
3. Ocean waters, navigable streams, and beaches
    - General provisions (HAR Chapter 13-250)
    - Local ocean waters (HAR Chapter 13-254)
    - Ocean recreation management rules (HAR Chapter 13-256)

Division of State Parks

1. Hawai‘i State Park System (HAR Chapter 13-146)

Division of Forestry and Wildlife

1. Threatened and endangered plants (HAR Chapter 13-107)
2. Indigenous wildlife, endangered and threatened wildlife, injurious wildlife, introduced wild birds, and introduced wildlife (HAR Chapter 13-124)

State Historic Preservation Division

1. Rules governing requirements for archaeological site preservation and development (HAR Chapter 13-277)
2. Rules governing procedures for Historic Preservation review to comment on HRS § 6E-42 Projects (HAR Chapter 13-284)

3. Rules of practice and procedure relating to burial sites and human remains (HAR Chapter 13-300)

Hawai‘i Community Development Authority

1. He‘eia Community Development District (HRS §§ 206E-202 to 205)

6.4.4 Federal Agency Regulations

U.S. Army Corps of Engineers

USACE regulates impacts on wetlands and navigable waterways, including discharges of fill material into water bodies and wetlands.

1. *Section 10 of the Rivers and Harbors Act of 1899* requires approval prior to the accomplishment of any work in, over, or under navigable waters of the United States, or which affects the course, location, condition, or capacity of such waters.

2. *Section 404 of the CWA* requires approval prior to discharging dredged or fill material into the waters of the United States.

   Waters of the United States (33 CFR Part 328) include essentially all surface waters, including all navigable waters and their tributaries, all interstate waters and their tributaries, all impoundments of these waters, all wetlands adjacent to these waters, and certain isolated wetlands.

3. *Section 103 of the Marine Protection Research and Sanctuaries Act* requires approval for the transportation of dredged material for the purpose of dumping it in ocean waters at disposal sites previously approved by EPA.

National Ocean and Atmospheric Administration

1. NOAA regulates the take of threatened and endangered marine species (50 CFR 222—General Endangered and Threatened Marine Species)
2. NOAA also regulates the take of marine mammals (50 CFR 216—Marine Mammals)

U.S. Fish and Wildlife Service

1. USFWS regulates the take of threatened and endangered species (50 CFR 17—Endangered and Threatened Wildlife and Plants)
2. USFWS also regulates the take of migratory birds (50 CFR 21 –Migratory Bird Permits)

6.5 Allowable and Unallowable Uses in the He‘eia NERR

This section describes, by major land or water component, the current allowable and unallowable uses in the He‘eia NERR. The allowable or unallowable uses are identified based on the existing specific rules and regulations of federal, state, and county regulatory agencies, including whether permits or licenses are required for the land use or activity. Designating the He‘eia NERR does not, in of itself, add new regulations on uses or activities within the boundaries, however, as a NERR, certain activities which are inconsistent with the purpose of the He‘eia NERR and its research programs may be prevented from occurring within the boundaries. Current and future uses will be discussed and evaluated as the different He‘eia NERR programs develop and priorities are identified for implementing actions compatible with the He‘eia NERR Program and the intent of this management plan. Updated descriptions of compatible uses will be incorporated into the management plan when it is updated in the future.

Hawai‘i Institute of Marine Biology—Moku o Lo‘e

Moku o Lo‘e is owned by the University of Hawaii Foundation and managed by UH, and UH policies pertain to visitor use and access to the island (see Section 7 for more details). The island is included in the general subzone of the State Land Use Conservation District, and use of Conservation District lands is regulated by HAR Chapter 13-5 and HRS Chapter 183C. These rules and regulations identify land uses that may be allowed by discretionary permit, and impose fines for violations. Moku o Lo‘e is also located in the county designated special management area (SMA). Any major facilities development or significant disturbance of important natural and cultural resources on the island would require a Conservation District Use Permit (CDUP) from DLNR and an SMA permit from the City and County of Honolulu.

Hawai‘i Marine Laboratory Refuge

The Hawai‘i Marine Laboratory Refuge consists of 64 acres of reefs and bay waters surrounding Moku o Lo‘e in Kāne‘ohe Bay, from the high-water mark on the island seaward to 25 feet beyond the outer edges of the reefs (Figure 6-1). It is unlawful to take any aquatic life from within the boundaries of the refuge; an exception is made for UH personnel employed in catching or taking aquatic life for scientific purposes. It is illegal to remove fish, shells, coral, or other living organisms from the water without a DLNR Special Activities Permit (HIMB 2015). In addition, it is important for the health of the reef that visitors do not step on the coral, nor disturb any research gear, instruments, or cages that they might find in the water. All authorized taking of aquatic life must follow minimum size and closed season restrictions for certain species, as well as gear restrictions and other applicable rules (DAR 2015).

Table 6-1. Types of Allowable and Unallowable Uses by Major Land/Water Components in He‘eia NERR

Allowable or Unallowable Land Use[1]	He‘eia NERR Land/Water Component					
	Moku o Lo‘e (HIMB)	Hawai‘i Marine Laboratory Refuge	State Marine Waters and Submerged Lands	He‘eia Fishpond	He‘eia State Park	He‘eia CDD
Dredging or filling of Wetland or Waters of the U.S.	Yes*	Yes*^	Yes*^	Yes*	Yes*	Yes*
Major Facilities (buildings) Development	Yes*	No	No	Yes*	Yes*^	Yes*^
Conduct Research Activities or Deploy Research Equipment	Yes*	Yes*	Yes*	Yes*	Yes*	Yes*#
Scientific Collection or Destructive Sampling	Yes*	Yes*	Yes*	Yes*#	Yes*	Yes*#
Handling of Cultural Resources	Yes*	Yes*	Yes*	Yes*	Yes*	Yes*#
Commercial Ocean Recreation Activities	NA	No	Yes*	No	Yes*	NA
Commercial Fishing	No	No	Yes*	No	Yes*	NA
Recreational Fishing	No	No	Yes	No	Yes	NA
Boat Moorage (>72 hrs)	NA	No	Yes*^	NA	NA	NA
Hunting	No	NA	NA	No	No	No

Notes:

HIMB = Hawaii Institute of Marine Biology

[1] Yes = Activity is allowed in this land/water component of He‘eia NERR. No = Activity is not allowed in this land/water component of He‘eia NERR. NA = Activity is not applicable in this He‘eia NERR component.

*License or permit required.

^Only in designated areas.

#Landowner or Lessee permission needed for activity or access

State Marine Waters and Submerged Lands

The marine waters of Kāneʻohe Bay are located in a State Ocean Recreation Management Area (ORMA) which is used for recreational and commercial purposes including fishing, boating, thrill craft riding, skiing, diving, snorkeling, swimming, eco-tours, and research. As is currently permitted by law, personal recreational activities such as snorkeling, kayaking, fishing, and paddling will be allowed throughout the Heʻeia NERR as described in HAR Chapter 13-256 Subchapter 1 and HAR Chapter 13-256-73. Commercial recreational activities will continue to be allowed only in designated zones as defined in HAR Chapter 13-256. Any and all permits required for activities in the Bay will continue to be required.

The commercial recreational activities permitted in the Heʻeia NERR according to HAR Chapter 13-256-73 include the following:

- Commercial thrill craft: allowed in Zone A restricted zone, also referred to as the Checker Reef commercial thrill craft zone;
- Commercial and recreational water ski and water sledding: allowed in Zone G restricted zone, a nonexclusive commercial water ski and water sledding zone;
- Commercial ocean water sports: allowed in Zone J restricted zone, a nonexclusive commercial ocean water sports zone. Zone J1 allows commercial water skiing and water sledding.

These zones are included in the buffer area of Heʻeia NERR, shown in Figure 1.5.

DOBOR also manages and regulates Heʻeia Kea Small Boat Harbor facilities in Kāneʻohe Bay which is located nearby. One of the four designated small boat mooring areas in the bay is located in the Heʻeia NERR (DOBOR 2015) (HAR Chapter 13-235). Boat mooring longer than 72 hours requires a permit from DOBOR. The boat mooring area is indicated in Figure 1.5.

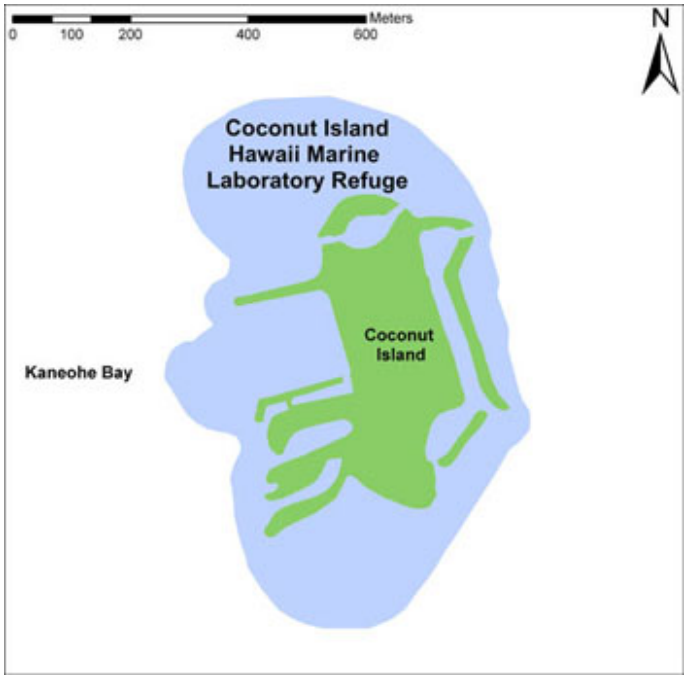

Figure 6.1. Coconut Island (Moku o Loʻe) Hawaiʻi Marine Laboratory Refuge – designated for research purposes

(Figure 6-1 map and table courtesy of DLNR-DAR website.)

Location:	The Hawaiʻi Marine Laboratory Refuge consists of the reefs and bay waters surrounding Moku o Loʻe, located in Kāneʻohe Bay, from the high-water mark on the island seaward to 25 feet beyond the outer edges of the reefs.
Prohibited:	It is unlawful to take any aquatic life from within the boundaries of the refuge.
Permitted:	The above restriction does not apply to any officer, faculty member, employee, or student of the UH, or licensee of the Board of Regents of UH, while employed in catching or taking of aquatic life for scientific purposes. All authorized taking of aquatic life must follow minimum size and closed season restrictions for certain species, gear restrictions, and other applicable rules.

Figure 6.2. Kayaking and stand up paddle boarding, some recreation activities allowed in the He‘eia NERR

(Photo Credit: Holokai Kayak & Snorkel Adventure)

Any development of facilities, permanent installation of research instruments, dredging, or filling of submerged state lands requires a permit from DLNR. Dredging or filling in marine waters requires a permit from USACE and a water quality certification from the Hawai‘i Department of Health.

Scientific collection or destructive sampling of aquatic flora, fauna, coral, or other living organisms may require permits issued by DAR. Scientific collection or destructive sampling of birds may require permits issued by DOFAW. Scientific collection or destructive sampling of federally protected species such as migratory birds, threatened or endangered species, or marine mammals may require permits issued by the USFWS or NMFS.

He‘eia Fishpond

He‘eia Fishpond is owned by Kamehameha Schools. It is a traditional aquaculture pond that is being repaired and managed by Paepae o He‘eia under a long-term lease from Kamehameha Schools in order to preserve the integrity of the fishpond and support a unique cultural, educational, and aquacultural program. Paepae o He‘eia staff, community volunteers, He‘eia NERR partners, and school groups work to restore and operate the pond using traditional aquaculture methods that avoid the use of heavy machinery. The program offers educational tours, workdays, and community harvesting of resources from the pond. Because the fishpond is on private property, public access is controlled by permission of the landowner or lessee. Educational tours and community access are scheduled by Paepae o He‘eia.

The property is in the resource subzone of the Conservation District, and in the City and County of Honolulu’s designated SMA. It is classified as a wetland. Any He‘eia NERR program development of facilities, permanent installation of research instruments, dredging, or filling of submerged state lands on

this property would require a CDUP from DLNR and an SMA permit from the City and County of Honolulu. Dredging or filling in the fishpond also would require a permit from USACE and the Hawai‘i Department of Health. Operation of the fishpond requires an aquaculture license and an aquaculture facilities license issued by DAR. Scientific collection or destructive sampling of flora, fauna, coral, or other living organisms from the pond may require permits issued by DAR or DOFAW. Scientific collection or destructive sampling of federally protected species such as migratory birds, threatened or endangered species, or marine mammals would require permits issued by USFWS or NMFS. Disturbance of cultural resources would require permits from SHPD.

He‘eia State Park

He‘eia State Park is an 18.5-acre park that is owned by DLNR as part of its state park system. The park is currently leased by Kama‘āina Kids, a private, nonprofit multiservice organization dedicated to serving children and their families through quality childcare programs (Kama‘āina Kids 2015a). The organization’s services include preschool programs, before and after school programs, environmental education programs, and enrichment programs, many of which are offered at He‘eia State Park. He‘eia State Park also has commercial use facilities, including a large visitor center where Kama‘āina Kids holds classes, a cultural gift shop, and a large banquet hall and outdoor pavilion that can be rented by individuals, families, and community organizations for meetings, lū‘au celebrations, weddings, and other special events. The park is open to the general public from 7:00 a.m. to 7:00 p.m., Monday through Sunday, per established operating hours (Kama‘āina Kids 2015b).

Any He‘eia NERR-related facilities development activities on state park lands would require a license amendment or special use permit issued by the Division of State Parks and/or DLNR. General park use and provision of public safety are regulated by state park rules (Division of State Parks 2015). Operation of the childhood education programs and community nature education, outreach, and ecotourism activities are managed by Kama‘āina Kids and authorized under license from the Division of State Parks. Any collection of or destructive sampling of flora, fauna, coral, or other living organisms may require permits issued by the Division of State Parks, DAR, or DOFAW.

He‘eia Community Development District (CDD)

HCDA obtained ownership of the He‘eia Wetland in 1991 in a land exchange agreement. In 2010, HCDA executed a 38-year lease for the area to Kāko‘o ‘Ōiwi, a Hawai‘i non-profit corporation. In 2011, the State Legislature established the He‘eia Community Development District (He‘eia CDD) with the mission to facilitate cultural practices, culturally appropriate agriculture, education and natural resource restoration and management of the He‘eia wetlands. Kāko‘o ‘Ōiwi is converting the currently fallow lands of Hoi (the He‘eia wetlands) into a working agricultural landscape (Townscape 2011a). The majority of the site is zoned urban but the He‘eia CDD statutes dictate that the site be used for cultural practices, culturally appropriate agriculture, education, and natural resource restoration and management of the He‘eia wetlands.

The upland forests are in the general subzone of the state Conservation District. Most of the agricultural lands and much of the upland forested area is in the City and County of Honolulu's designated Special Management Area (SMA). Much of the property is classified as wetland.

Kākoʻo ʻŌiwi staff, community volunteers, Heʻeia NERR partners, and school groups work to restore and operate the farmlands using traditional agricultural methods that avoid the use of heavy machinery. The program offers educational tours, workdays, and community restoration and management of taro loʻi. As semiprivate property, public access is controlled by permission of the landowner or agent. Educational tours, hiking, wildlife watching, and community access are scheduled by Kākoʻo ʻŌiwi.

Any construction of facilities, permanent installation of research instruments and scientific collection or destructive sampling, dredging, or filling of wetlands or disturbance of natural or cultural resources on Conservation District lands located on the site may require permits from SHPD, DLNR, HIDOH, City and County of Honolulu, USFWS or the USACE.

Section 7. Public Access and Visitor Use Plan

The public access and visitor use plan is a required element of a NERR management plan, per Code of Federal Regulations 15 CFR 921.13. Public access can be defined as the ability of all members of the community to pass physically and visually to, from, and along the ocean shore, other waterfronts, and over public lands. A public access plan must try to allow long-term public use and enjoyment of the water and shoreline while minimizing damage to the resources.

This plan will support the public access and visitor-use related objectives and strategies listed below and identified in the He‘eia NERR Strategic Plan.

He‘eia NERR Public Access and Visitor-Use Related Objectives and Strategies

Objective 3: Integrate traditional knowledge and research in the He‘eia NERR that will better reflect and inform community decision making toward creating a sustainable ecosystem.	**Strategy 3(b):** Coordinate periodic community meetings to inform the community about upcoming scientific research opportunities, gather input to guide further research, and share ongoing research results.
Objective 4: Increase student, educator, and community understanding of estuaries in general and in particular Hawaiian estuaries, coastal habitats, and the ahupua‘a land management system.	**Strategy 4(f):** Provide site-specific educational experiences that facilitate hands-on exploration of the upland, estuarine, and marine environments in the He‘eia estuary with site partners.
Objective 7: Engage and educate the community on the practices and values of the ahupua‘a land management system; in other words, promote ‘āina momona and enhanced stewardship efforts by all sectors of the community, to increase their understanding of how human activities and natural events affect the estuary.	**Strategy 7(a):** Provide a variety of hands-on stewardship experiences to the community groups and visitors.
Objective 9: Develop the tools, capacity and connections to increase public awareness across the community, island, state, nation, and the world of the	**Strategy 9(a):** Engage with site partners and other organizations such as local civic clubs to

ecological and cultural significance of the Heʻeia estuary and ultimately the entire ahupuaʻa of Heʻeia.	implement public outreach activities in the Heʻeia ahupuaʻa.

7.1 Public Access and Visitor Use at Heʻeia NERR

Public access is important to achieving the Heʻeia NERR's vision of conserving and sustaining coastal areas for future generations. Public access allows for recreational and educational opportunities that promote the image of the Heʻeia NERR and increase visitor appreciation and understanding of natural resources. Public use of the Heʻeia NERR will provide opportunities to develop and strengthen connections with local communities and to promote awareness and stewardship of coastal resources.

Public access, according to the landowners' policies regarding access, for commercial and recreational uses of the Heʻeia NERR will continue, and are supported by the roadways, trails, boat launch, piers, and docks in and adjacent to the Heʻeia NERR and identified under "Current Facilities," in Figure 7.1. Additional public access facilities are available in the Heʻeia Kea Small Boat Harbor and private marinas located adjacent to the Heʻeia NERR in Kāneʻohe Bay. Adequate water access is critical to facilitating and conducting research and monitoring in the marine portions of the Heʻeia NERR. Also, public boat ramps and trails are an important infrastructural improvement that will be used in many of the research, education, and stewardship programs and projects.

15 CFR 921.13(a) requires planning for public access as part of a NERR management plan. Table 7-1 provides a summary of current public access points and uses in the Heʻeia NERR and the major physical components of the Heʻeia NERR. Public access to the Heʻeia NERR will be determined by, and be compatible with, the public access policy of each of the agencies and site partners that have title to or management responsibility for the lands (i.e., HIMB, DLNR, Kakoʻo ʻŌiwi and Paepae o Heʻeia). Specific policies regarding access for education, stewardship, research, and monitoring will be determined through coordination with each of the Heʻeia NERR site partners and the RAB. Access to public lands for fishing, recreation, and gathering will not be impeded in any way by the Heʻeia NERR designation.

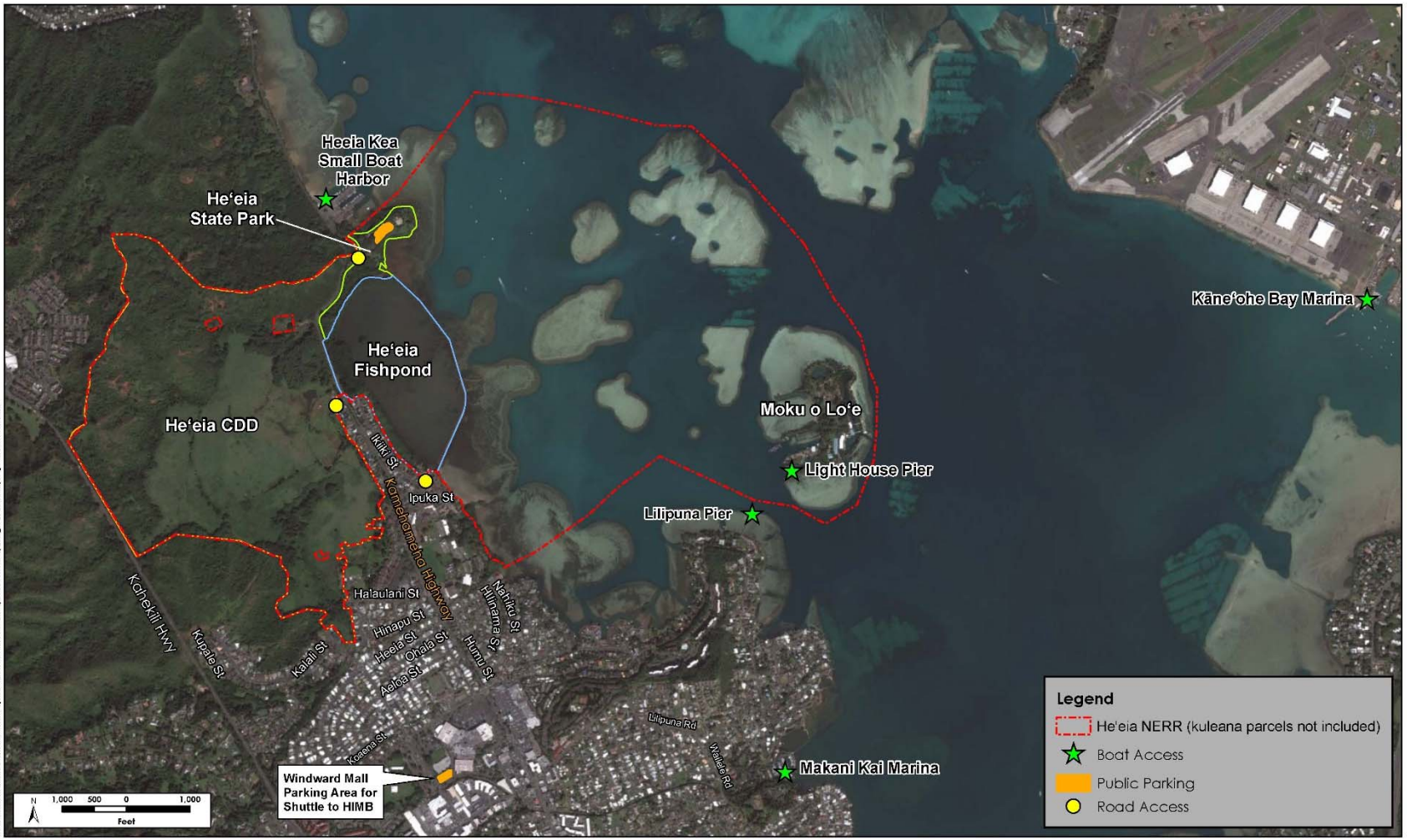

Figure 7.1. Current Public Access at He'eia NERR

7.2 Description of Public Access Points to the He‘eia NERR

The main road access to the He‘eia NERR is Highway 830 (Kamehameha Highway), which runs north-south along the coast through Kāne‘ohe (Figure 7-1). USACE designated navigation channels run through Kāne‘ohe Bay just outside the He‘eia NERR boundary (NOAA 2015). Marine transport in the He‘eia NERR includes the marine taxi that runs to Moku o Lo‘e from Lilipuna Pier (HIMB 2015). Public access to the marine waters of the He‘eia NERR for recreational and commercial small boat traffic will be provided by the He‘eia Kea Small Boat Harbor and boat ramp. The harbor has berths, moorings (some of which are located in the He‘eia NERR boundary), three boat ramps, fish host, Marine Sanitation Device pumpout, anchorage by permit (some are located within the He‘eia NERR boundary), vessel washdown, a harbor office, restrooms, showers, fuel, food, and ice. Access to the marine waters of the He‘eia NERR can also be gained from the Kāne‘ohe Bay Marina on Marine Corps Base Hawai‘i; the Makani Kai Marina, and from the Kāne‘ohe Yacht Club (not shown). Researchers working with HIMB will continue to access marine waters using the docks, piers, and boat facilities on Moku o Lo‘e. Public tours of the research facilities and island, led by docents, will continue as part of the education and outreach efforts of the He‘eia NERR.

Access to conduct administrative business will be via HIMB. The He‘eia NERR administrative office will initially be located on Moku o Lo‘e, co-located with the HIMB administrative offices. Visitors to Moku o Lo‘e must have a He‘eia NERR sponsor or an HIMB sponsor and complete a visitor waiver form prior to arrival. Special events will be arranged and sponsored by the He‘eia NERR staff. Access to Moku o Lo‘e is via 1-minute shuttle boat ride to the Light House Pier on the island from the Lilipuna Pier, located outside the He‘eia NERR boundary on the Kāne‘ohe Bay shoreline. Most educational boat tours through HIMB depart from He‘eia Kea Small Boat Harbor. Public parking is available at Windward Mall in Kāne‘ohe, and HIMB provides a shuttle service from Windward Mall to Lilipuna Pier. The administrative hours of HIMB (and the He‘eia NERR) are 7:00 a.m. to 5:30 p.m. on weekdays, and 8:00 a.m. to 5:00 p.m. on weekends. Regular weekday shuttle boat service operates from the Lilipuna Pier to the Light House Pier. Special arrangements would need to be made for off hours transport. As visitor use facilities are developed for the He‘eia NERR, it is anticipated that He‘eia State Park, with its ample parking and visitor use facilities, will become the point of entry for visitors to the He‘eia NERR and provide administrative office space and an operational base for He‘eia NERR staff members.

7.3 Permitted Public Uses at He‘eia NERR

The following paragraphs outline access to and appropriate uses of state lands and waters and the He‘eia NERR uplands. All of the uses described below contribute to community access to the NERR and provide opportunities for education and increased public awareness of issues related to the management of coastal resources.

Allowable uses in the He‘eia NERR will include both commercial and recreational activities (Table 7-1). Commercial and recreational fishing conducted per state regulations, as well as non-consumptive recreational

uses such as birdwatching, boating, kayaking, water skiing, diving, snorkeling, picnicking, and nature photography, will continue to be allowed in the He‘eia NERR and its waters. Public recreational uses of private lands in the He‘eia NERR are as outlined below and occur with the permission of the landowner. Commercial small boat traffic to facilitate ecotourism is regulated by DOBOR, and activities, uses, and permits are issued under its Ocean Recreation program (DOBOR 2015).

Table 7-1. Types of Public Access and Use by Major Land/Water Components in the He‘eia NERR

	Public Access and Uses[1]											
Major Component	**Commercial Ocean Recreation Activities**	**Commercial Fishing**	**Recreational Fishing**	**Boat Moorage (>72 hrs)**	**Diving/Snorkeling**	**Swimming**	**Beach Access**	**Wildlife Viewing**	**Hunting**	**Hiking Trails**	**Educational Tours**	**Group Meeting Facilities**
Moku o Lo‘e (HIMB)	NA	No	No	NA	NA	NA	Yes	Yes	No	Yes	Yes	Yes
Hawai‘i Marine Laboratory Refuge	No	No	No	No	Yes	Yes	NA	Yes	NA	NA	Yes	NA
State marine waters	No	Yes*	Yes	Yes*^	Yes	Yes	NA	Yes	NA	NA	Yes	NA
Ocean Recreation Management Area (ORMA) Zones	Yes*	Yes*	Yes	No	Yes	Yes	NA	Yes	NA	NA	Yes	NA
He‘eia Fishpond	No	No	No	NA	No	No	No	Yes	No	No	Yes	Yes
He‘eia State Park	Yes*	Yes*	Yes	NA	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes
He‘eia CDD	NA	NA	NA	NA	NA	NA	NA	Yes	No	Yes	Yes	Yes
He‘eia Stream	No	Yes*	Yes*	No	Yes	Yes	Yes	Yes	NA	NA	Yes	NA

Notes:

[1] Yes = The He‘eia NERR component is accessible/appropriate for this use. No = The He‘eia NERR component is not accessible/appropriate for this use. NA = The public access or use is not applicable to this He‘eia NERR component.

*License or permit required.

^Only in designated areas.

Allowable commercial activities include boat mooring/anchorage under permit issued by DLNR’s DOBOR, commercial fishing under an individual commercial fishing license (for sale of personal catch), and commercial recreational tours under permit issued by DOBOR. These tours include water thrill-craft riding, skiing, and sledding; nature tours for snorkeling, diving, and nature viewing; fishing; kayaking; and boating. Also, commercial agricultural and aquacultural operations are carried out on the He‘eia CDD and in the He‘eia Fishpond. At the He‘eia State Park facilities, commercial use activities such as private parties, wedding receptions, meetings, ecotours, kayaking, boating, snorkeling, child care and early education are allowed under permit and fee from DLNR State Parks Division. Uses that are not allowed include entry without permission onto private (kuleana) lands which are not included in the He‘eia NERR and He‘eia Fishpond leased to Paepae

o He‘eia, and extraction of resources from the Hawai‘i Marine Laboratory Refuge surrounding Moku o Lo‘e (see Section 6.1.7 for restrictions).

If not listed in the paragraphs above, commercial uses of submerged lands and bay waters within the He‘eia NERR boundaries are prohibited unless approved by a permit issued by DLNR.

The He‘eia NERR will have no law enforcement jurisdiction; it will rely on DLNR and City and County of Honolulu law enforcement agencies to enforce regulations pertaining to public safety, traffic, hunting, fishing, boating, and other activities.

On public lands and waters, the He‘eia NERR will not impose restrictions or use restraints on outside researchers, but permits may be required by DLNR, USFWS, and/or NOAA for destructive sampling or collecting of plants or vertebrates. Access to and research on all lands in the He‘eia NERR will require the permission of the landowners or their agents.

7.3.1 Public Access Challenges

Public access to portions of the He‘eia NERR is controlled or limited due to the nature of landownership and/or the activities occurring there. The He‘eia Fishpond is private property leased to Paepae o He‘eia, who has the right to control access to protect its facilities and aquacultural products. Kako‘o ‘Ōiwi leases the He‘eia CDD from HCDA and has the right to control access to protect its facilities and agricultural products. Public use of private property introduces the possibility that someone may be hurt while visiting and sue the private landowner or operator for damages, a risk that many private landowners are reluctant to take. To protect against potential suit, both operators allow access at special events or by invitation, and require visitors to sign a waiver of liability to come onto the property. Access is also limited at HIMB. Similarly, because of the need to protect sensitive research equipment, facilities, and sites, HIMB requires visitors to have a He‘eia NERR or HIMB sponsor and sign a waiver of liability.

The He‘eia NERR designation does not supersede the landowners’ or lessees’ rights to control or restrict access to their property. He‘eia NERR education, research, and restoration activities requiring access to the fishpond, He‘eia wetlands, and HIMB will require advanced planning, coordination and communication between the site partners, He‘eia NERR staff and the public. Visitors to the He‘eia NERR will need to sign liability waivers, and be aware of and adhere to the He‘eia NERR tour rules and public access hours.

7.3.2 Public Access and Visitor Experience Opportunities

There may be increased opportunities for the public to access the area after the He‘eia NERR is designated. This could include centralized access through He‘eia State Park, where people could park their vehicles and possibly walk to the site partners facilities. There could be an organized annual open house, announced through a public notice, where there would be guided tours of each facility. Access could be provided independently by the site partners. The He‘eia NERR management plan calls for more hands-on experiences for the public,

and this is another opportunity for managed visitor access that is consistent with He‘eia NERR management plan goals and objectives.

Section 8. Facilities and Infrastructure Development and Improvement Plan

The He‘eia NERR facilities provide functional space for He‘eia NERR work and programming, as well as serve as a place for public interaction. When facilities are developed, they should be planned as sustainable facilities. The He‘eia NERR is responsible for providing the facilities necessary to fulfill the He‘eia NERR’s mission and support its research, education, cultural, and natural resource stewardship and training programs.

8.1 Current Facilities and Infrastructure at He‘eia NERR

The following existing facilities at the various He‘eia NERR site partner properties will be used to meet He‘eia NERR mission goals and objectives (Table 8-1).

Table 8-1. Existing Facilities and Equipment at He‘eia NERR Site Partner Properties

HIMB	Paepae o He‘eia Fishpond	He‘eia State Park	He‘eia CDD
Administrative offices	He‘eia Fishpond	Visitor center/gift shop	Maintenance buildings
Classroom, library, and laboratory buildings	Education pavilion	Exhibit hall	Education pavilion
Maintenance sheds	Office	Banquet hall	Maintenance roads
Housing for students and faculty	Caretaker’s residence	Canoe hale	
Research tanks and pens	Restrooms	Outdoor pavilion	
Docks/piers (Light House Pier on Moku o Lo‘e)	Equipment and storage	2 boat launch sites	
Human-made lagoons	Parking (11 stalls)	Caretaker’s residence	
Six 17’ whalers Two 22’ whalers	Aquaculture holding tanks	Maintenance buildings	
Honu Kai (vessel cap. 40)	Water filtration system	Parking lot (80 stalls)	
Community education program boat (cap. 49)		Beach and shoreline access	
		Hiking/walking trail	

Figure 8.1 Facilities and Infrastructure in He‘eia NERR

The administrative offices for the He‘eia NERR will initially be located at the HIMB campus on Moku o Lo‘e. This will provide a base of operations and logistics support to get the He‘eia NERR programs started. The location and layout of facilities at the HIMB campus are detailed in Figure 8-2.

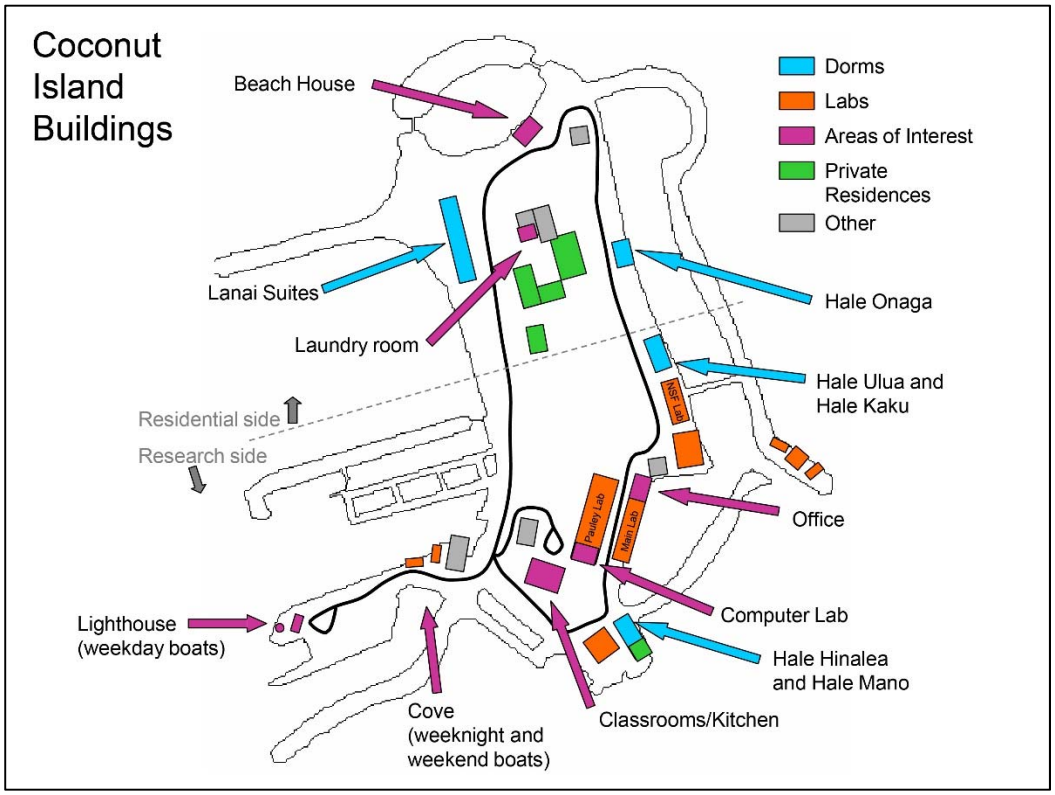

Figure 8-2. HIMB facilities on Moku o Lo‘e (Coconut Island)

(Map provided by HIMB)

HIMB has a number of vessels for use by research and education personnel as well as visiting groups. For educational programs, vessels usually provide access to the reefs departing from He‘eia Kea Small Boat Harbor. The HIMB fleet includes six 17' Whalers (capacity 7 people), two 22' Whalers (capacity 10 people), vessel named Honu Kai (capacity 40 people), and a community education program boat (capacity 49 people).

It is anticipated that He‘eia State Park, with its public parking lot and visitor-use facilities, will become one of the main points of entry for visitors to the He‘eia NERR (Figure 8-3). The park currently has ample parking spaces and room for cars, vans, and buses, which will bring visitors, school groups, and tourists to the site. The park also has ample room for development of a community education, research, and visitor center for the He‘eia NERR. While these visitor use facilities are being developed, it is anticipated that HIMB will provide interim office space and an operational base for the Education Coordinator and other He‘eia NERR staff.

8.2 Facilities and Infrastructure Challenges and Gaps

As the He‘eia NERR grows during its first 5 years of operation, these existing facilities will likely need to be improved or expanded upon to adequately meet growing program needs. Items like dedicated office space, additional storage, expanded laboratory and educational facilities, and increased community meeting space may be needed.

Table 8-2. Standard Reserve Facilities Configuration

Administration and Support	Research	Education
Offices and meeting space 2,925 ft^2	Laboratory 2,453 ft^2	Exhibit and reception 2,061 ft^2
Kitchen 376 ft^2	GIS operations 177 ft^2	Offices 640 ft^2
Storage 1,206 ft^2	Office 789 ft^2	Classroom 1,321 ft^2
Restroom 584 ft^2	Outside storage 1,317 ft^2	Storage 253 ft^2
Maintenance 2,159 ft^2	Inside storage 428 ft^2	Library 306 ft^2
Other 2,321 ft^2	Dorms 1,846 ft^2	Auditorium 1,116 ft^2
	Other 1,350 ft^2	Other 1,193 ft^2

Note: ft^2 = square feet.

Table courtesy of University of Wisconsin-Extension

A list of typical facilities needed to support the basic requirements of reserves is used by many new reserves for planning purposes (University of Wisconsin-Extension 2010). This list is based on a 2004 inventory and assessment of existing reserves. The standard reserve facilities configuration in Table 8-2 identifies the common facilities and average square footage at existing reserves and provides a basis for new reserves, such as the He‘eia NERR, to plan for long-term facility needs. The He‘eia NERR may use this information while conducting the long-term facilities assessment.

A facilities challenge for the He‘eia NERR is the lack of large, dedicated meeting and teaching space to support larger school groups and community groups for the education program. These need to be in a location that is convenient for public access and parking, including school buses. The He‘eia State Park has large meeting rooms that can be used for education, and also has ample parking, but is already in use by Kama‘āina Kids for early child care, youth and community education programs. There are two outdoor education pavilions at Kako‘o ‘Ōiwi and Paepae o He‘eia, but both are small and temporary and lacks sufficient parking at each site. HIMB has larger facilities, but parking and access to Moku o Lo‘e is challenging due to the required arrival by small shuttle boat.

Another facilities challenge is adequate space for administrative and program staff in a location accessible to the public. The He‘eia NERR core staff, i.e. the Reserve Manager, Research Coordinator, and Education Coordinator, will be located at HIMB during the startup period of the He‘eia NERR. HIMB has limited space and there are logistics challenges of getting access to the island via the shuttle boat. It also has limited public access. Having an office and baseyard facility located on Oahu, perhaps at the state park, would provide better

logistics for conducting field work at terrestrial sites in the He‘eia NERR, and provide greater accessibility to He‘eia NERR staff for site partners and the public.

Figure 8-3. He‘eia State Park Facilities

(Map courtesy of Kama‘āina Kids)

8.3 Planned Facilities and Infrastructure Development at He‘eia NERR

He‘eia NERR partners currently have facilities that will be available upon He‘eia NERR designation for NERR program needs, but additional facilities may be needed between 2017 and 2021, and in the long term to address future NERR program needs. During the first 5 years of operation, the He‘eia NERR will install the necessary SWMP infrastructure as well as evaluate future facilities’ needs and pursue solutions as feasible to enhance or develop facilities within the 5-year term; the He‘eia NERR also will develop a prioritized list of facility needs for the long term. As funds become available, facility development will proceed based on this list of priorities. All facilities will comply with federal, state, and local codes and regulations. In addition, any new facilities will be designed and constructed using sustainable building principles and in a manner that minimizes environmental impacts to the extent feasible, to integrate with and enhance He‘eia NERR educational and learning objectives.

He‘eia NERR staff and the RAB will identify future facility needs through a planning process. This process will provide details of what facilities will be needed and when, and will identify the site partner responsible for specific facility development. An analysis of the long-term future facilities needs will be explored during the first 5 years after designation. The analysis will identify facility needs which may include: a visitor center, office space, laboratories, classrooms, and equipment storage, which may be necessary for the successful operation of the He‘eia NERR. The analysis will also determine the extent to which the existing site partner facilities meet the He‘eia NERR’s needs. The He‘eia NERR site partners have a common desire for an interpretive facility that can serve as a visitor center, He‘eia NERR office and research and management base of operations, library, and repository for information about the He‘eia NERR.

Options that could be used to address facility needs include renovating existing He‘eia NERR site partner buildings or constructing new facilities on site partner’s properties. Development or expansion of new facilities will depend on agreed upon priorities and availability of funding and receipt of all required permits and approvals.

8.4 Climate and Non-climate Stressors

As He‘eia NERR staff and the RAB identify future facility needs through the planning process described above, they will include consideration of climate and non-climate stressors that may affect facilities. The types of stressors typically considered include climate change, environmental impacts, social impacts and feasibility. In 2010, NOAA developed a framework for considering climate change impacts in planning and decision making for coastal investments in restoration, facilities development, and land acquisition. The climate stressors pertinent to He‘eia NERR facility development planning should include changes in relative sea levels, changes in storm intensity, and changes in precipitation patterns. The non-climate stressors should include other natural hazards (tsunami, flood, fire, rockfall, and erosion), considerations of environmental impacts,

ability to meet program needs, and sustainability of use including lifespan. Consideration of these stressors will be incorporated into the planning process described above.

The He‘eia NERR Staff and the RAB planning process will use the facilities planning tools developed for the NERRS program including the guide for “Planning for Sustainable Facilities” (NOAA 2013). This tool has guidance on incorporating climate change impacts and green or sustainable building practices that are environmentally responsible and resource efficient throughout a building’s life-cycle, from siting to deconstruction.

Some of the considerations for siting to avoid potential climate change impacts at the He‘eia NERR site include the reality that most of the land within the He‘eia NERR is either a low island, or at elevations less than 20 feet along the shoreline or just inland. Some of the highest ground in the He‘eia NERR is at He‘eia State Park at 57 feet elevation. These coastal locations are susceptible to a combination of sea level rise and increased storm surge hazards related to climate change. In considering these factors, the site partners identified He‘eia State Park as a potential site to consider in the planning process for visitor center development. This will need to be further evaluated during the facility planning process.

Section 9. Land Acquisition Plan

In many estuaries in Hawai‘i, human development has significantly eliminated or degraded the coastal habitat. In the case of the He‘eia NERR, there is another important cultural consideration for future land acquisition. A key vision of the community in designating the He‘eia NERR is for it to be restored and managed as a traditional ahupua‘a. This will involve adding additional lands to the He‘eia NERR by appropriate means, the easiest of which is a willing landowner voluntarily dedicating their land’s inclusion in the He‘eia NERR under a cooperative agreement. “Land Acquisition” is the term used in the NERRS to describe the process to add lands to the He‘eia NERR. This plan will support the land acquisition-related objectives and strategies listed below and identified in the He‘eia NERR Strategic Plan.

He‘eia NERR Land Acquisition-Related Objectives and Strategies

Objective 1. Baseline environmental data informs researchers’ understanding of the magnitude of changes in the various He‘eia ecosystems.	**Strategy 1(f)**: Create opportunities to conduct research within the ahupua‘a, potentially outside the He‘eia NERR boundaries, that provides relevant information about impacts on the entire ahupua‘a of He‘eia, to inform the long-term vision of a healthy He‘eia ahupua‘a.
Objective 4. Increase student, educator, and community understanding of estuaries in general and in particular Hawaiian estuaries, coastal habitats, and the ahupua‘a land management system.	**Strategy 4(e):** He‘eia NERR staff develop programs that incorporate information about the entire ahupua‘a of He‘eia.
Objective 10. Support restoration of key areas in the He‘eia NERR to improve habitat and increase ecosystem services.	**Strategy 10(b).** Revise land acquisition and habitat restoration projects, taking into account climate change impacts.

9.1 Description of Potential Acquisition Areas

One of the visions of the community in designating the He‘eia NERR is for it to be restored and managed as a traditional ahupua‘a system with its ecological, cultural, social, and economic benefits to the community. To realize that vision, the boundaries of the He‘eia NERR would need to be extended farther upstream and encompass additional lands in the upland portions of the ahupua‘a that make up its upper watershed and include

the headwaters of He‘eia Stream. The parcels listed in Table 9-1 and shown in Figure 9-1 were identified in the public scoping or management plan development process; and the site partners and members of the community support investigating the potential for these parcels to be incorporated into the He‘eia NERR in the future. Each potential parcel’s contribution to the research that is done within the He‘eia NERR would be evaluated in light of restoration and manipulation results in the He‘eia NERR in order to consider the benefits from expanding the He‘eia NERR to include certain parcels. The potential areas include 4 large parcels in the upper portion of the ahupua‘a of He‘eia that contain important watershed forests and the headwaters of He‘eia Stream, the forested hillside area above the He‘eia Kea Small Boat Harbor, and the He‘eia Kea Small Boat Harbor itself. Adding the He‘eia Kea Small Boat Harbor was suggested so that additional public harbor facilities could be incorporated into the He‘eia NERR to ensure and improve public access to marine portions of the He‘eia NERR. If all the sites listed in Table 9-1 were added, the He‘eia NERR would increase in size by 1,076 acres.

9.2 Priority Areas Acquisition Strategy

9.2.1 Tract Acquisition Strategy

The vision to expand the He‘eia NERR to encompass the traditional ahupua‘a recognizes the unique opportunity provided by the He‘eia NERR to represent an entire watershed, from the stream’s mountain origin to the estuary and ocean, with its reefs and marine habitats which accept the fresh water.

To expand the boundary to include more of the traditional ahupua‘a, parcels will be considered that are under adequate state or local government control and for which the appropriate uses would be consistent with the goals and objectives of the He‘eia NERR. These publicly owned lands must meet the criterion of being under “state or local government control” and be eligible to add to the He‘eia NERR. The lands could be added to the He‘eia NERR by the current owner agreeing to add their lands to the He‘eia NERR and entering a cooperative agreement with UH, or by executing a land transfer or land exchange to one of the He‘eia NERR state agency partners. The success of restoration and manipulation activities within the He‘eia NERR will be considered and the results from ecosystem-based management (EBM) strategy monitoring taken into account when evaluating potential acquisition areas.

9.2.2 Climate and Nonclimate Stressors

Acquisition planning typically involves assessing anthropogenic and natural stressors, to inform the prioritization and selection of land acquisitions. Types of stressors typically considered include the threat of development, invasive species, and land zoning. Climate-related stressors have not been commonly factored into these processes. In 2010, NOAA developed a framework for considering climate change impacts in planning and decision making for coastal investments in restoration, facilities development, and land acquisition. That framework states that new or updated acquisition plans that are part of NERR management plans must integrate climate considerations. The climate stressors pertinent to the He‘eia NERR are changes in relative sea levels, changes in storm intensity, and changes in precipitation patterns.

Table 9-2 summarizes the climate and nonclimate stressors relevant to the Heʻeia NERR land acquisition strategy and prioritization. The parcels being considered were assigned a relative score based on the potential for the acquisition to have no effect, a positive benefit, or a negative effect in relation to the stressor. The site with the highest positive score has the best attributes when considering a combination of climate and nonclimate stressors. Based on the stressors evaluated, the Department of Hawaiian Homelands (DHHL) and DOFAW upland watershed parcels and the City and County of Honolulu stream parcels would have the fewest negative considerations regarding climate and nonclimate stressors, and the Heʻeia Kea Small Boat Harbor would have the most negative considerations.

Table 9-1. Parcels for Consideration for Future Inclusion in the Heʻeia NERR

Parcel	Acreage	Landowner	Considerations	Attributes and Land Use Status
Forested Conservation Lands above Heʻeia Kea Small Boat Harbor	204 acres	City and County of Honolulu	Potentially developable land that the County may value and choose to retain	Local government-controlled parcel is partially zoned as preservation (P-1/P-2) and partially as residential (R-10); located outside the subwatershed (doesn't drain into Heʻeia Stream); flat area suitable for development.
Heʻeia Kea Small Boat Harbor	13 acres of water and a 1-acre pier	DLNR/ DOBOR	Multiple additional user groups to consider; traffic congestion and accessibility issues	State government controlled in conservation district, would provide additional access to bay for user groups; groups such as fishermen and tour operators already use the pier and boat launch.
Upland watershed parcel	259 acres	DLNR/DOFAW	Identified as an important watershed forest component of the ahupuaʻa. Parcel is part of state Waiāhole forest reserve (Ioleka'a section) with limited public access. The parcel is part of the Koʻolau Mountains Watershed Partnership (KMWP). Parcel could be added to Heʻeia NERR through cooperative agreement with DLNR.	State government controlled in conservation district; contains mixed native and introduced wet forest habitat being managed for watershed protection, water resources, biodiversity protection, cultural resources, and education as part of the larger KMWP management plan. Funding is limited with little active management in progress. Parcel is not contiguous with the Heʻeia NERR.

Parcel	Acreage	Landowner	Considerations	Attributes and Land Use Status
Upland watershed parcel	138 acres	Department of Hawaiian Home Lands (DHHL)	Identified as an important watershed forest component of the ahupuaʻa. Parcel is part of Koʻolau Mountains Watershed Partnership (KMWP) but management status is unknown; land may be added to Heʻeia NERR through cooperative agreement or by land transfer.	State government controlled in conservation district; contains mixed native and introduced wet forest habitat being protected for watershed values, contains extensive cultural sites such as burials and historical sites and a former Coast Guard OMEGA station; very good vantage point to view entire ahupuaʻa system; current oversight of the area is not active; no management plan is in place for these parcels; is not contiguous with the Heʻeia NERR.
Heʻeia Stream upland Parcels (2)	461 acres	City and County of Honolulu	Both parcels identified as important headwater stream components of the ahupuaʻa. Both are part of Koʻolau Mountains Watershed Partnership (KMWP) but management status is unknown; may be added to Heʻeia NERR through cooperative agreement or a land transfer may be possible between agencies; lower reaches of the stream flows through private land between the upper watershed and the Heʻeia NERR.	Local government controlled in conservation district; would provide additional monitoring/ research sites for upstream species and environmental conditions; parcels are not contiguous with the Heʻeia NERR.

Notes: DHHL = Department of Hawaiian Homelands; DLNR = Department of Land and Natural Resources; DOBOR = Division of Boating and Ocean Recreation; DOFAW = Division of Forestry and Wildlife

9.2.3 Tract Ecological and Programmatic Values

The parcels identified for possible future inclusion in the He‘eia NERR have many ecological and programmatic values. Most of the proposed additions would expand the He‘eia NERR within the traditional ahupua‘a, encompassing a greater portion of the He‘eia watershed. These additions would provide a more complete watershed and estuary system to research and monitor the ecosystem services provided by both manipulation and restoration activities within the He‘eia NERR. The various ecological and programmatic values for each potential parcel are summarized in Table 9-3.

9.2.4 Methods for Establishing State Control

According to the national reserve system federal regulations, a reserve must establish adequate state control over new areas acquired for inclusion in the reserve boundary. The various approaches to achieve state control include entering a management agreement for the site, regulation, less-than-fee simple property interest (conservation easement), fee simple property acquisition, donation, or a combination of these approaches.

All of the parcels identified for boundary expansion are public lands, owned or managed by state or local government agencies. These government owned parcels have the potential to be voluntarily added to the He‘eia NERR by entering into a Multi-Party Governance Charter with UH as the He‘eia NERR state partner. The current landowners would not lose ultimate control over their properties, but would agree to manage their lands consistent with the goals and objectives of the He‘eia NERR. Managing the lands in a way that is consistent with the goals and objectives of the He‘eia NERR would also improve the environmental conditions on the lands and provide secondary benefits of ecological services, and for the benefit of Native Hawaiians in the case of the DHHL parcel. The landowners would also be eligible to receive funding for implementing programs that protect and restore their lands, and for providing additional services to the public.

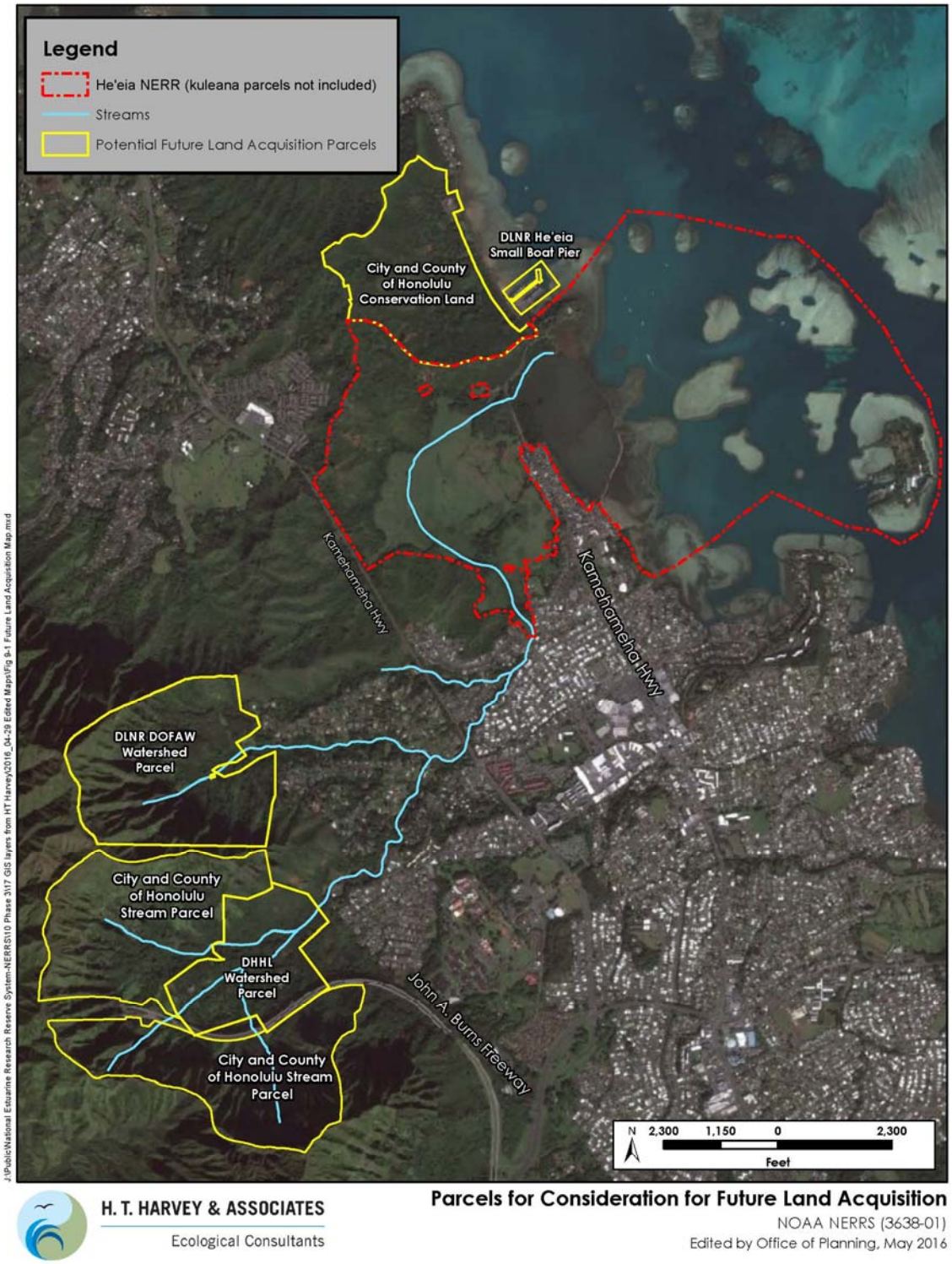

Figure 9.1. Parcels for Consideration for Future Inclusion in He'eia NERR

Table 9-2. Climate and Nonclimate Stressors and Their Relative Impacts* on Land Parcels under Consideration for Acquisition

	Potential Acquisition Parcel			
	City and County of Honolulu Forested Conservation Lands above He'eia Kea Small Boat Harbor	**DLNR He'eia Kea Small Boat Harbor**	**DLNR DOFAW and DHHL Upland Watershed Parcels (2)**	**City and County of Honolulu He'eia Upland Stream Parcels (2)**
Site Characteristics				
Size (acres)	204	14	397	461
Habitat	Degraded lowland forest habitat	Developed public use facilities; nearshore reef and mud flat	Mixed native and nonnative watershed forest; DLNR parcel is designated critical habitat for 3 listed Hawaiian damselflies and 43 listed plants that occupy lowland wet habitat.	Stream course and parcels with mixed native and nonnative forest; designated critical habitat for 3 listed Hawaiian damselflies and 43 listed plants that occupy lowland wet habitat.
Elevation limits (feet above sea level)	20–718	0–20	280–2400	200–2000
Climate Stressors				
Sea level rise	1	-1	0	0
Storm intensity	-1	-1	-1	-1
Climatic factor of flooding	-1	0	1	1
Climatic factor of drought	-1	0	-1	-1
Nonclimate Stressors				
Threats of development	1	1	-1	-1
Exposure to visitor use impacts	-1	-1	0	0
Exposure to invasive species impacts	-1	-1	1	1
Ability to support key ecosystem features, habitat, and species	0	-1	1	1
Relative Stressor Score	-3	-4	0	0

***** The stressor factors are assigned a relative value, indicating a positive, negative, or no-effect impact to be considered in prioritizing land for acquisition. If the land is not affected by the stressor = 0 value, if positively affected by the stressor = +1 value, or if negatively affected by the stressor = -1 value. The relative priority ranking is sum of values across all stressors.

Table 9-3. Ecological and Programmatic Values of Potential Acquisition Areas

Area	Acreage	Landowner	Ecological Values/Habitats	Programmatic Values
Forested Conservation Lands above He‘eia Kea Small Boat Harbor	204 acres	City and County of Honolulu	Forested watershed; habitat suitable for native species restoration; empties into the He‘eia NERR and affects core marine areas; would add to buffer area of He‘eia NERR	Would add watershed area of the ahupua‘a of He‘eia to the He‘eia NERR, add cultural history and cultural sites, expand buffer area that, if managed properly, would reduce impacts on core marine areas, and provide additional sites for hiking and recreation
He‘eia Kea Small Boat Harbor	13 acres of water and a 1-acre pier	DLNR-DOBOR	Additional coral reef habitat; would add to buffer area of He‘eia NERR	Would provide additional public facilities for access to marine portions of He‘eia NERR; has infrastructure that would support public access for expanded educational, research, and stewardship projects
Upland watershed parcel	259 acres	DLNR-DOFAW	Forested watershed; contains upper reaches of He‘eia Stream; habitat suitable for native species restoration; critical habitat; would add to buffer area of He‘eia NERR	Would add watershed area of the ahupua‘a of He‘eia to the He‘eia NERR, appropriate site for stewardship projects; would add watershed areas appropriate for studying watershed dynamics that affect the core, would expand buffer area to protect the water quality and quantity flowing into the lower estuary, increased management would reduce impacts on core marine areas; would provide additional sites for hiking and recreation
Upland watershed parcel	138 acres	DHHL	Forested watershed; contains upper reaches of He‘eia Stream; habitat suitable for native species restoration; would add to buffer area of He‘eia NERR	Would add watershed area of the ahupua‘a of He‘eia to the He‘eia NERR and would add extensive cultural sites such as burials and historical sites; very good vantage point to view entire ahupua‘a system; has infrastructure that would support public access and expanded educational, research, and stewardship projects; increased management would reduce impacts on core marine areas would provide additional sites for hiking and recreation

Area	Acreage	Landowner	Ecological Values/Habitats	Programmatic Values
He‘eia Stream upland Parcels (2)	461 acres	City and County of Honolulu	Would add upper reaches of He‘eia Stream tributaries; habitat suitable for native species restoration; critical habitat; empties into the He‘eia NERR and affects core marine areas; would add to buffer area of He‘eia NERR	Would add monitoring and research sites for studying upstream species and conditions, and cultural history and cultural sites; would expand buffer area that increased management would reduce impacts on core marine areas; would provide additional sites for hiking and recreation

If an agency is reluctant or unable to enter into a Multi-Party Governance Charter, there are other ways to acquire land for the He‘eia NERR. For example, if DHHL is unable to dedicate lands entirely to conservation purposes, or is reluctant to commit to long-term management control and oversight by another state or federal agency, the exchange of another piece of property of comparable value is possible. DLNR and the City & County of Honolulu have land holdings that could be considered for such an exchange, which would be subject to their internal review and approval processes.

9.2.5 Fair Market Value Estimates

Because the land acquisitions discussed above primarily target state or local government lands, it is not anticipated that the properties would be purchased; rather, they would be provided voluntarily by the state or local government entity, or in an exchange for comparable lands where required. Therefore, fair market value estimates are not needed. If for some reason a land trade, actual sale, or other ownership transfer requires a fair market value estimate; such estimates will be developed as part of the investigation of the property.

9.2.6 Estimated Acquisition Timeline

All of the parcels identified for boundary expansion are public lands, owned or managed by state or local government agencies. Because these government lands have the potential to be voluntarily added to the He‘eia NERR through a cooperative agreement with UH, and not requiring any land exchanges or sale, the timeline to complete the process could be relatively short. It should take up to 1 year to develop the concept paper and reach out to the appropriate contacts in the state or county agency to introduce the idea. It may take a number of years for the agency to evaluate the proposal and reach a decision. The agency being asked to join the He‘eia NERR partnership may want to evaluate the success of the program before committing. Interest and support from the community will help in making the case for the target agency to join the He‘eia NERR partnership.

Section 10. Resource Manipulation

"Resource Manipulation" is the term used in the NERRS to describe human activities such as agriculture, commercial recreation, development and operation of research and public use facilities and infrastructure improvements such as harbors, roads, and utilities that modify the natural condition. In some cases these activities also provide important ecosystem services to the natural systems. When occurring within He'eia NERR boundaries, these manipulation activities should be compatible with the He'eia NERR's vision and mission and be limited in nature and extent to the minimum manipulative activity necessary to accomplish its stated research objective. The resource manipulation-related objectives and strategies identified in the He'eia NERR Strategic Plan are as follows.

He'eia NERR Resource Manipulation-Related Objectives and Strategies

Objective 1: Baseline environmental data informs researchers' understanding of the magnitude of changes in the various He'eia ecosystems.	**Strategy 1(j):** Establish a site experimental design that supports ecosystem-based management research approach.
Objective 6: Integrate traditional knowledge and contemporary science to effectively address climate change, habitat restoration, and water quality.	**Strategy 6(d):** Provide technical assistance to site partners in support of ongoing traditional agricultural (taro lo'i) and aquaculture (He'eia fishpond) practices.
Objective 7: Engage and educate the community on the practices and values of the ahupua'a land management system; in other words, promote 'āina momona and enhanced stewardship efforts by all sectors of the community, to increase their understanding of how human activities and natural events affect the estuary.	**Strategy 7(a):** Provide a variety of hands-on stewardship experiences to the community groups and visitors.
	Strategy 7(b): Collaborate with partners to incorporate He'eia NERR science, traditional knowledge and information in the rehabilitation of historical, agricultural and aquacultural resources within the He'eia NERR.

10.1 Overview of Current and Proposed Resource Manipulation at He‘eia NERR

There are a number of current and proposed resource manipulation activities within the He‘eia NERR. Conducting these activities in the He‘eia NERR is intended to support research into the changes in the He‘eia NERR ecosystem as evidenced by the ecosystem services provided by the areas being actively manipulated through agricultural and aquacultural activities. Using an ecosystem-based management (EBM) research framework, targeted ecosystem services affected by either the research-based manipulation activities or restoration activities (Section 11) will be evaluated and assessed over time to improve the long-term management and sustainability of the He‘eia NERR and a broad spectrum of Hawaiian estuarine environments. Examples of the ecosystem services which the manipulation activities are expected to provide include sustainable fishery stocks, soil and nutrient retention, species biodiversity and habitat enhancement, and flood protection.

Soil erosion, fertilizer and pesticide runoff, and animal waste can end up in streams, estuary and marine habitats, potentially damaging He‘eia NERR resources. Currently, the wetlands in He‘eia are overgrown and dominated by weeds and California grass, which provide very poor habitat for native birds and aquatic species and are susceptible to wild fires and erosion. Converting these habitats to organic lo‘i kalo is expected to result in a useful crop to feed the community, potentially mitigate climate and non-climate stressors, and offer the opportunity to understand how and to what extent the lo‘i kalo support multiple ecosystem services as listed in Table 1.8. For example, the rehabilitation of the lo‘i kalo is expected to open up habitat for native birds and aquatic species, retain soil and nutrients, clean groundwater, and restore water flow to the downstream wetlands and fishpond. In support of the effort to rehabilitate the lo‘i kalo, maintenance roads will be rehabilitated and water conveyances will be installed to properly manage these areas (See Figure 10.1).

He‘eia Fishpond, which is a long-term, preexisting use in He‘eia, is the recipient of fresh water from He‘eia Stream. Invasive mangrove and seaweed damage the walls and clog the pond, and are being removed to reestablish a sustainable food chain to support aquaculture production. The fresh stream water flows through the fishpond and out into the bay. If the fishpond is well managed and has a balanced system, it is expected to support ecosystem services as listed in Table 1.8, particularly improving water quality for estuarine and marine habitats, supporting both coral and fish in the bay and native and cultivated fish stocks in the pond. Rebuilding and maintaining the fishpond will strengthen it against impacts from climate-related stressors of sea-level rise and frequent more severe storms which may over-top the walls and damage this cultural resource. Controlling invasive mangrove and algae and improving water quality in the fishpond will help clean up this portion of the estuary and improve conditions on the adjacent reefs. Research and monitoring in the fishpond offer the opportunity to understand how and to what extent the activities in the fishpond support these multiple ecosystem services.

Without the current and planned agricultural and aquacultural rehabilitation efforts, the wetland and estuarine habitats in these areas would likely degrade further and deteriorate with neglect. The He‘eia NERR establishes the connections for site partners to communicate and share what is working right, and adaptively manage their respective sites to sustain operations without adversely affecting their neighbor or resources of the He‘eia NERR. If managed wisely, both the estuarine and marine systems will be healthy, and the resources and community they support will flourish. Moreover, from a cultural perspective, the lo‘i kalo and loko i‘a are traditional land uses in the ahupua‘a of He‘eia and these two site partners, Paepae o He‘eia and Kāko‘o ‘Ōiwi, are critical partners to realizing the community’s vision of the overall restoration of the ahupua‘a of He‘eia. These manipulation areas in the He‘eia NERR, coupled with the restoration activities discussed in Section 11, offer the opportunity to identify the ecosystem services provided by each management strategy and monitor the strategies’ success in creating a more resilient and sustainable estuary. Implementing these two strategies under the framework of a NERR is expected to enable He‘eia to provide significant insight into the effective management of estuarine systems in the insular biogeographic region.

10.2 Specific Resource Manipulation Activities at He‘eia NERR

The manipulation activities at He‘eia NERR are informed by management and conservation plans previously developed by site partners. The He‘eia NERR and site partners intend to work collaboratively toward implementing and expanding these projects over the years as planning and funding become available. The expansion of the manipulation activities would depend on their ability to contribute to answering the overarching research question of which management strategies enhance ecosystem services for the site, and would take place where adaptive management of the area is possible. As the He‘eia NERR programs are developed and implemented, He‘eia NERR staff and the RAB may adaptively manage the site according to the results of monitoring and research efforts which gauge the ecosystem services that these manipulation activities provide, and accordingly seek resources to support these activities.

The He‘eia NERR designation offers the chance to monitor and document the habitat changes and ecosystem services provided by manipulation and restoration activities. Monitoring these services, such as filtering and storing rainwater, will be valuable for informing research and adaptive management decisions in the area.

10.2.1 Kāko‘o ‘Ōiwi—Reconstruction of Wetland and Upland Traditional Landscapes

As part of its efforts to support traditional agricultural and according to their Māhuahua ‘Ai o Hoi Plan, Kāko‘o ‘Ōiwi is converting the currently fallow lands of Hoi (the wetlands within the He‘eia CDD) into a working agricultural landscape with organic lo‘i kalo in the wetlands (Townscape 2011a) (Figure 10-1). This area lies within the He‘eia NERR buffer. The He‘eia NERR’s role will support the efforts of Kāko‘o ‘Ōiwi by providing technical assistance, monitoring, establishing baseline conditions for research, and planning assistance.

Manipulation elements of the Māhuahua ʻAi o Hoi Plan include:

- Restoring the historic loʻi of Heʻeia to active production of organic taro;
- Practicing organic agriculture within existing agricultural areas;
- Practicing aquaponics in order to support educational goals and
- Restoring and maintaining the minimum extent of the historic agricultural and safety roads necessary to ensure access to the agricultural and restoration areas that are supporting the Heʻeia NERR primary research question and other activities;
- Restoring historic loko iʻa kalo, or traditional combined taro patches and fishponds, in the makai brackish areas of the wetlands;
- Managing sediment and debris to reduce impacts on agricultural areas and downstream areas; and
- Developing the necessary agricultural and community support facilities in upland areas, including an historic poi mill, community/education center, and maintain existing agricultural and community support infrastructure including a Hawaiian hale, base yards, and composting facilities.

Table 10.1 Current and Proposed Resource Manipulation Activities within the He‘eia CDD

Area	Manipulation Activity	Current or Proposed	Potential ecosystem services provided	Permissible basis
He‘eia CDD	Taro patches	Current/expansion proposed	Habitat for native birds, fish; soil and nutrient retention; clean groundwater; restore water flow; cultural traditions	Research purposes
	Combined taro and fishpond	Proposed	Habitat for native birds, fish; soil and nutrient retention; clean groundwater; cultural traditions	Research purposes
	Dryland agriculture	Current	Food security, cultural traditions, soil and nutrient retention	Research and education purposes
	Aquaponics	Current/expansion proposed	Support and repopulate native fish stocks and seaweed populations	Research purposes
	Maintenance roads and water conveyances	Current/expansion proposed	Support and enable rehabilitation and maintenance of the area	Support research purposes
	Community/education center	Proposed	Cultural traditions	Research and education purposes
	Historic poi mill	Proposed	Cultural traditions, food security	Research and education purposes

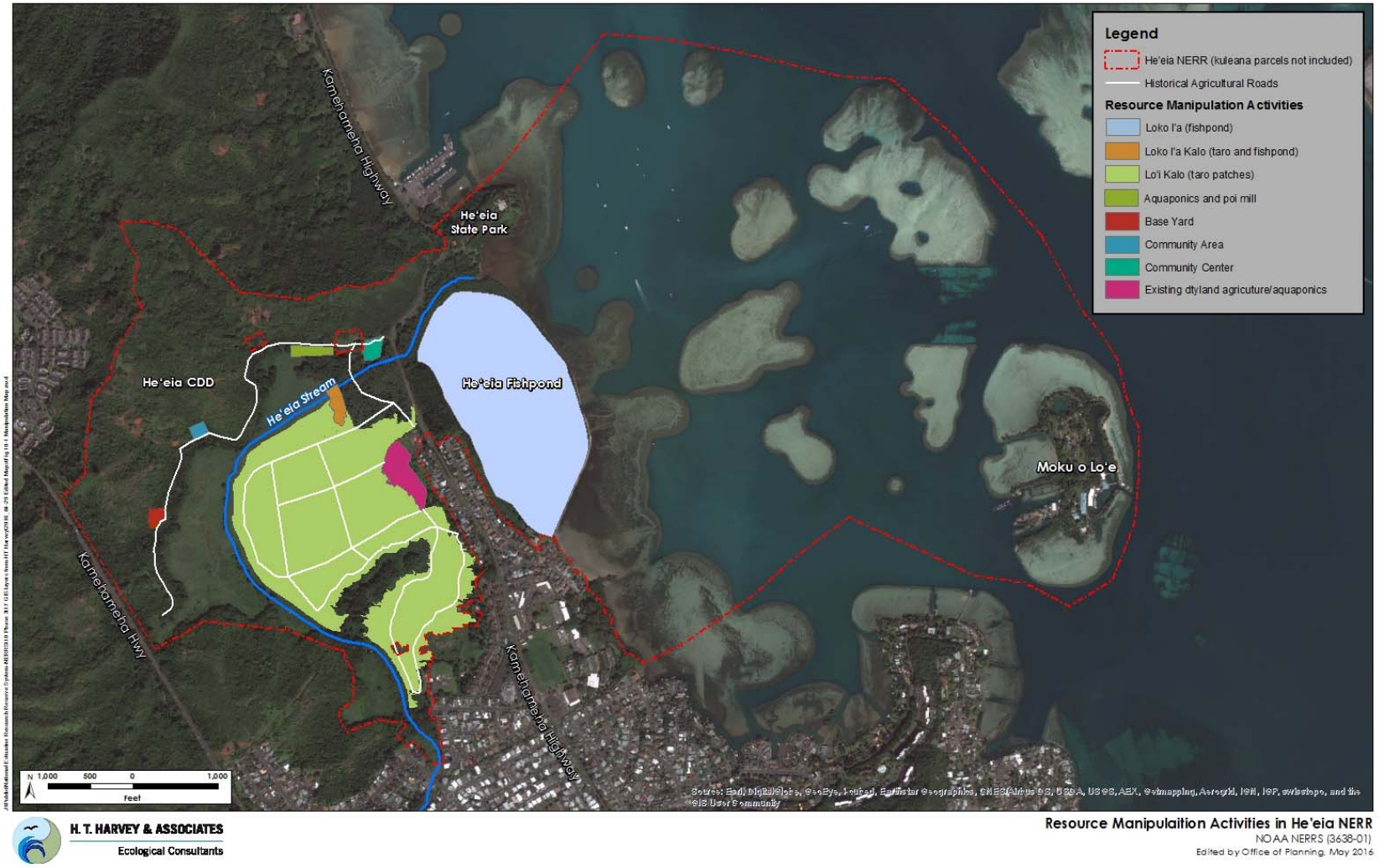

Figure 10.1 Manipulation Projects within the He‘eia NERR

Loʻi Kalo

The cultivation of loʻi kalo (taro patches) is a manipulation activity historically done in the area and will continue to be conducted within the Heʻeia NERR for research purposes. The rehabilitation of the loʻi kalo for research purposes offers the chance to enhance and monitor the ecosystem services provided by the wetland area which includes native wildlife habitat, soil and nutrient retention, clean groundwater, and restored water flow. Kākoʻo ʻŌiwi is the main site partner involved in the rehabilitation of the loʻi kalo and they receive guidance from the Koʻolaupoko Hawaiian Civic Club regarding historical activities in the area. Heʻeia NERR staff will support the efforts of Kākoʻo ʻŌiwi by providing technical assistance, monitoring, establishing baseline conditions for research, and planning assistance.

As part of the rehabilitation of organic loʻi kalo in the wetlands of Heʻeia, historic kuāuna (taro patch walls) have been identified by a certified archaeologist as part of an archaeological inventory survey and will be restored to the extent possible (Soltz et. al. 2014). New kuāuna will be constructed to replace kuāuna from earlier times that are no longer present. Kuāuna will be built by excavating soil from within the loʻi and using this soil to create the kuāuna. The loʻi kalo will be used to grow different varieties of taro and will also serve as habitat for native birds. In order to enhance the habitat benefits of loʻi kalo areas for native birds, Kākoʻo ʻŌiwi will also develop and implement a predator control program for rats, mongooses, cats, and dogs in cooperation with USFW and DOFAW. As recommended by USFWS, Kākoʻo ʻŌiwi will develop a plan for early identification and response to sightings of avian botulism in the area (Townscape 2011b).

Figure 10.2. Kākoʻo ʻŌiwi plans include the production of taro for food and enhancement of habitat for native species

(Photo courtesy of Kākoʻo ʻŌiwi)

Historical agricultural roads and ʻauwai (water conveyance channels) also remain in the wetlands of Heʻeia and will be identified through the archaeological inventory survey (some have already been identified). To the extent necessary to fulfill the research and restoration activities in the Heʻeia NERR, these roads will be rehabilitated and reinforced with geotextile material; the ʻauwai channels will also be restored and revegetated with native riparian vegetation. These roads and water conveyance infrastructure will enable the Heʻeia NERR staff and site partners to access the areas that are supporting the Heʻeia NERR's primary research question and other activities.

Additionally, the Heʻeia NERR partners are planning to reestablish historic loko iʻa kalo in the wetter parts of the wetlands in the makai portion of the property. The loko iʻa kalo which was historically present in the area will serve several purposes, including production of fish and taro for consumption, trapping of sediment during rain events, and provision of native bird habitat. Aquaponics, much like the loko iʻa kalo, will be used to cultivate and support fish stocks, which will then be placed in the stream. The aquaponics system will also support the growth of native limu. Water used for the aquaponics system will be well or tap water, and will not be taken from or added to the stream.

Following a hydrology and hydraulic study to better understand streamflow under various storm conditions, Heʻeia NERR in partnership with Kākoʻo ʻŌiwi may explore stormwater management options to help slow down stormflows and retain sediments and debris, which will minimize impacts on loʻi kalo and other wetland areas as well as the fishpond and bay.

10.2.2 Paepae o Heʻeia—Heʻeia Fishpond Reconstruction and Aquaculture Farming

Heʻeia Fishpond is a loko kuapā (walled fishpond) with a unique 7,000-foot-long wall that completely encircles the pond. Paepae o Heʻeia is a private non-profit organization that aims to rehabilitate the ancient kuapā (fishpond wall) and manage the fishpond to support a unique cultural, educational, and aquacultural program (Paepae o Heʻeia 2015). The fishpond is a long-term, pre-existing habitat manipulation activity in the area. It is anticipated that the rehabilitation and management of the fishpond may support enhanced ecosystem services such as native wildlife habitat including native seaweed restoration, and improved estuarine and marine water quality. It is expected that these rehabilitation and management activities, and the enhanced ecosystem services resulting therefrom, will support the overall research objectives of the Heʻeia NERR, and therefore, the Heʻeia NERR intends to support the efforts of Paepae o Heʻeia by providing technical assistance, monitoring, establishing baseline conditions for research, and planning assistance.

Table 10.2 Current and Proposed Resource Manipulation Activities within the He‘eia Fishpond

Area	Manipulation Activity	Current or Proposed	Potential ecosystem services provided	Permissible basis
He‘eia Fishpond	Fish cultivation	Current	Improve estuarine and marine water quality; repopulate native and cultivated fish stocks	Long-term pre-existing use
	Invasive mangrove and seaweed removal on fishpond wall	Current	Support native seaweed restoration to support native habitat restoration	Research purposes

Mangrove Removal

A vital part of the rehabilitation of the He‘eia Fishpond is to remove the invasive mangrove. Several species of mangrove grow in Hawai‘i, but the most prevalent near the fishpond is Rhizophora mangle (red mangrove), which grows in thick forests with tangles of aerial roots. Introduced to the He‘eia wetlands in approximately 1922 to control erosion and stabilize sediment, mangrove trees spread quickly through all parts of the fishpond and accelerated the process of silt buildup. Also, as the plant grows in the fishpond wall, its many aerial roots loosen the rocks and coral, undermining the wall’s structural integrity.

Mangrove removal efforts began in the late 1990s with the former fishpond lessee, Mary Brooks, with help from students from UH. Paepae o He‘eia began removing mangrove in earnest in 2001, using simple handsaws and loppers, and later chainsaws. Thousands of volunteers working tens of thousands of labor hours have been devoted to removing mangrove over the years. As of 2016, Paepae o He‘eia had physically removed mangrove from over 3,500 feet of the 7,000-foot-long kuapā.

Kuapā Rehabilitation

Once the larger mangroves are removed, the damaged portions of the wall can be reconstructed. In some areas, the wall is broken down to the niho (foundation) stones, and in other areas, only one or two rocks have fallen off the top. Paepae o He‘eia works with the same materials originally used to create the kuapā: pōhaku pele (volcanic rock) and ko‘a (coral). All invasive plants such as mangrove, pluchea (*Pluchea sp*.), pickleweed (*Batis maritima),* and other weeds will be removed to expose the bare wall.

Invasive Seaweed Removal

The removal of invasive limu (seaweed) is another manipulation activity that supports the long-term preexisting use of the fishpond. Removing the invasive limu improves the environment of the fishpond and enables the return of native seaweed (manauea and common ogo) as part of the habitat for native and cultivated fish stocks in the pond. The reef adjacent to He‘eia Fishpond is blanketed mainly by three species of invasive limu: *Kappaphycus* sp., *Acanthophora spicifera,* and *Gracilaria salicornia*. Fragments of these limu float into the pond during high tides and then establish themselves.

Paepae o He‘eia has removed invasive limu since 2004 with the help of community partners such as TNC, DAR, O‘ahu Invasive Species Council, and countless individual volunteers. Between 2004 and 2012, Paepae o He‘eia removed 50 tons of invasive limu from He‘eia Fishpond. The invasive limu is gathered by hand or net and placed into large bags. The limu is then used by mauka partners as fertilizer on their lo‘i kalo, ‘uala (sweet potato) patches, or any other type of garden. Paepae o He‘eia plans to continue with invasive species removal and reestablish a sustainable food chain in the fishpond to support aquaculture production.

Aquaculture Production

The use of the fishpond to produce aquacultural products is a long-term, pre-existing use of the area. Paepae o He‘eia plans to produce the aquacultural products listed below as part of a community-based economic development program to research, develop, and feature various products and services from the He‘eia Fishpond and make them available to the public. In doing so, the group hopes to mutually benefit both the fishpond and those whom it can nourish (Paepae o He‘eia 2015).

- **Moi (Pacific threadfin)—**Paepae o He‘eia has been successfully raising moi since 2006 and will continue to do so. The fish are offered for sale to restaurants and the public.
- **‘Ama‘ama (Striped or Grey Mullet)—**‘Ama‘ama is one of the historic fishpond species and an important food fish in ancient Hawai‘i. A very choice indigenous food fish that Paepae o He‘eia will continue to raise and offer for sale to restaurants and the public.
- **Limu as food (Gorilla ogo)—**Despite being an invasive pest, this seaweed is closely related to the native manauea and common ogo species that are commonly eaten. This product is not actively cultivated in the fishpond, but once removed as part of the invasive specie eradication efforts, it is offered for sale to restaurants and the public.
- **Limu as fertilizer—**Farmers have successfully used the invasive limu that grows in the fishpond to fertilize gardens and lo‘i. Individual farmers and members of the public are encouraged to gather limu themselves. If self-picked, limu is given away rather than sold.

- **Oysters (Pacific and Hawaiian)—**In collaboration with UH Hilo and the Pacific Aquaculture and Coastal Resources Center, Paepae o He‘eia is researching the survivability and growth rates of two species of edible oysters in He‘eia Fishpond.
- **Mangrove firewood—** Paepae o He‘eia occasionally gives away mangrove wood. The dense hard wood is useful as fuel for barbeques, imu, smoke houses, and other such purposes.
- **Mangrove wood for construction—**Mangrove wood is resistant to termites and bugs and can be used for hālau (meeting house) construction, hula implements, picture frames, lomi (massage) sticks, and other work. It is also given away rather than sold.



Figure 10.3. Aquacultural products from the He‘eia Fishpond include moi (Pacific Threadfin), limu (seaweed), and oysters

(Photo courtesy of Paepae o He‘eia)

The He‘eia Fishpond is intended to be a self-sufficient program that combines technical aquacultural operations with cultural and environmental educational activities and sustainable, community- based economic development initiatives. Paepae o He‘eia has also established an ecocultural educational program with hands-on research and learning activities. The group works with individuals, students, families, Hawaiian language immersion communities, and other organizations. Paepae o He‘eia plans to expand the educational and community outreach components of its program.

Section 11. Resource Restoration

Most NERRs in the system have habitats that are in less than pristine condition because of land uses and/or climate-related impacts. Resource restoration offers the opportunity for NERRs to support habitats in order to reestablish a self-sustaining habitat resembling a natural condition (Turner and Streever, 2002) and in doing so, inform the practice of restoration through hypothesis-driven restoration design. Restoration planning can take full advantage of the capability of NERR programs to prioritize and address climate and anthropogenic stressors. Within the national system, NERRs span the spectrum of restoration needs, from relatively intact systems with no readily apparent need for restoration, to those so altered that restoration may be the only way to achieve original ecosystem function. The level of detail and priorities needed in the restoration plan depend on where a NERR is along this continuum.

There are a number of resource restoration activities currently ongoing and proposed at the He‘eia NERR site. These include the restoration of native estuarine species following the removal of invasive mangroves, the restoration of the riparian area around He‘eia Stream, the removal of invasive algae on reefs in the bay, the establishment of a coral mitigation bank on two patch reefs in the bay, and the restoration of native forest in the uplands of the site. These restoration activities present an opportunity to monitor long-term changes in the ecosystem services provided by these areas as they are restored and to support the research goals and objectives of the He‘eia NERR. The resource restoration-related objectives and strategies identified in the He‘eia NERR Strategic Plan are listed below.

He‘eia NERR Restoration-Related Objectives and Strategies

Objective 1: Baseline environmental data informs researchers' understanding of the magnitude of changes in the various He‘eia ecosystems.	**Strategy 1(i):** Implement baseline biodiversity surveys with He‘eia NERR site partners.
	Strategy 1(j): Establish a site experimental design that supports ecosystem-based management research approach.
Objective 6: Integrate traditional knowledge and contemporary science to effectively address climate change, habitat restoration, and water quality.	**Strategy 6(a):** Utilize historical photos, testimonials, and other information to document the land use history of the ahupua‘a of He‘eia and incorporate into He‘eia NERR education and interpretative programs.

Objective 7: Engage and educate the community on the practices and values of the ahupuaʻa land management system; in other words, promote ʻāina momona and enhanced stewardship efforts by all sectors of the community, to increase their understanding of how human activities and natural events affect the estuary.	**Strategy 7(b):** Collaborate with partners to incorporate Heʻeia NERR science, traditional knowledge and information in the rehabilitation of historical, agricultural and aquacultural resources within the Heʻeia NERR.
Objective 10: Support contemporary restoration of key areas in the Heʻeia NERR to improve habitat and increase ecosystem services.	**Strategy 10(a):** Demonstrate restoration best practices in the land and estuarine stewardship of Heʻeia NERR natural resources that support climate change adaptation.
	Strategy 10(c): Heʻeia NERR uses a multi-disciplinary and multi- sector approach in the implementation of restoration initiatives.
	Strategy 10(d): Work with partners to develop and implement a hybrid ecosystem framework for upland reforestation.
	Strategy 10(e:) Provide technical and monitoring assistance to support the removal of mangrove habitat and replacement with native estuarine species.
	Strategy 10(f): Develop a restoration and monitoring plan in collaboration with partners to guide the restoration of the Heʻeia Stream and adjacent buffer.
	Strategy 10(g): Provide technical assistance and support for the removal of invasive species and the establishment native plant communities within the Heʻeia Stream buffer and stream channels.

	Strategy 10(h): Collaborate with partners on existing coral reef restoration and monitoring initiatives that are occuring within the marine boundaries of the He‘eia NERR.
	Strategy 10(i): Coordinate future restoration planning and monitoring activities within marine boundaries of the He‘eia NERR.

11.1 Current and Proposed Resource Restoration at He‘eia NERR

There are a number of current and proposed resource restoration activities within the He‘eia NERR. The role of the He‘eia NERR in the context of these activities is to increase our understanding of the changes in the ecosystem. Through the research and monitoring of ecosystem services provided by the areas being restored, the He‘eia NERR will help inform and adaptively manage these areas with partners in support of the vision and mission of the He‘eia NERR. Using an ecosystem-based management (EBM) research framework, targeted ecosystem services affected by either the restoration activities or the previously described research-based manipulation activities will be evaluated and assessed over time to improve the long-term management and sustainability of the He‘eia NERR and a broad spectrum of Hawaiian estuarine environments. Examples of the ecosystem services which the restoration activities are expected to impact include sustainable fishery stocks, soil and nutrient retention, species biodiversity and habitat enhancement, and flood protection.

Many of the habitats in He‘eia are degraded, and restoration is an appropriate and supported activity for these habitats within a NERR. For example, parts of the marine habitats in the He‘eia NERR have become overgrown with invasive algae, affected by disease, and suffer from the effects of erosion and siltation. These areas require restoration and ongoing active monitoring and management. Given the research framework described in Chapter 4, the He‘eia NERR plans to monitor and assess the resource restoration approaches in each habitat with specific control areas that have been left undisturbed and where no active management is taking place. These control areas, where no action is planned for the next five years under this management plan, directly support the He‘eia NERR’s efforts to monitor and assess ecosystem services provided under the different EBM approaches being implemented within the He‘eia NERR. An outcome of Strategy 1(j) as presented in the Strategic Plan in Section 3 and referenced in the table above in Section 11, is to identify treatment and control areas within each major ecosystem type for the He‘eia NERR.

This section outlines restoration efforts that are currently being implemented or proposed by site partners and contribute to the implementation of the Strategic Plan goals and objectives. As the He‘eia NERR programs are developed and implemented, He‘eia NERR staff and the RAB may adaptively manage the site

according to the results of monitoring and research efforts tied to these restoration activities and their associated ecosystem services. Accordingly, the He‘eia NERR may seek new resources to support these activities.

11.2 Specific Resource Restoration Activities at He‘eia NERR

The restoration activities currently being implemented or proposed are described below and identified in Figure 11.3. Efforts are guided by management and conservation plans developed by site partners, and include restoration of degraded wetland habitats, upland areas overrun by invasive species, and coral reef habitats affected by invasive algae and sedimentation. The restoration plans are informed by historical knowledge gathered from community partners about the area, and these efforts will continue and be supported by the activities of the He‘eia NERR.

11.2.1 Kāko‘o ‘Ōiwi—Estuarine Habitat Restoration

On the makai (seaward) part of the He‘eia CDD, an invasive mangrove forest has altered the He‘eia estuarine habitat and is choking the He‘eia Stream. The mangroves will be cut down and replaced with approximately 20 acres of native wetland sedges and open-water pools, which will serve as habitat for native birds and as a nursery for juvenile fish (Figure 11-3). To minimize potential impacts on the endangered Hawaiian hoary bat, removal of the mangrove trees will not be conducted during the bat’s breeding season, which extends from June 15 through September 15.

The re-establishment of native estuarine plants to replace the invasive mangroves may contribute to increased resilience of the estuary to climate change impacts through enhanced flood protection and shoreline stabilization. The restored estuary is also expected to enhance habitat for native aquatic species such as fish, algae and native sea turtles. Kāko‘o ‘Ōiwi is the main site partner for restoring the estuary within the He‘eia CDD, and the He‘eia NERR will coordinate with them to design and implement an effective monitoring strategy to understand and assess the effect of the restoration on the ecosystem services provided by the estuary. In addition to a monitoring strategy for the area, the He‘eia NERR will also provide technical assistance, help to establish baseline conditions, and offer planning functions to support these restoration activities being implemented by Kāko‘o ‘Ōiwi.

11.2.2 Kāko‘o ‘Ōiwi—Riparian Restoration

In the wetlands of He‘eia and in the He‘eia Stream channel (Figure 11-3), California grass and other invasive plants dramatically reduce water flow and adversely affect water quality (Figure 11-1). Water quality samples collected by HIMB in areas of the stream overgrown with California grass suggest that the oxygen content of the water is so low that it cannot support aquatic animals. Following a hydrologic and hydraulic study to better understand streamflow under various storm conditions, the stream channel and riparian area will be restored to improve water quality and flow and provide better habitat for native aquatic and bird species.

Kākoʻo ʻŌiwi plans to replace the current California grass and other invasive plants along the stream with native plants within an at least 100 ft. wide buffer along either side of the stream. Riparian area plants that may be introduced to replace the California grass include: Ahuʻawa Cyperus javanicus, ʻAkiʻaki (*Schoenoplecus spp*.), ʻAkulikuli (*Sesuvium portulacastrum*), Bacopa (*Bacopa monnieri*), Ihiʻihi (*Marsilea villosa*), Kaluha (*Bolboschoenus maritimus*), Makaloa (*Cyperus laevigatus*), Pycreus (*Pycreus polystchyos*), and ʻuki (*Cladium jamaicense*). The marsh habitat along the stream is known to occasionally provide feeding and loafing habitat for four endangered waterbirds: Hawaiian gallinule (*Gallinula chloropus sandvicensis*), Hawaiian duck or koloa (*Anas wyvilliana*), Hawaiian coot (*Fulica alai*), and the Hawaiian stilt (*Himantopus mexicanus knudseni*) and restoring the area with native plants is expected to enhance the habitat for these waterbirds.

The restoration of the stream channel and streambanks is expected to enhance habitat for native aquatic species such as fish, algae and native sea turtles, as well as help to stabilize the shoreline and retain soil and nutrients from eroding into the stream. This in turn may help to reduce harmful impacts to the fishpond and coral reefs downstream. Heʻeia NERR will coordinate with Kākoʻo ʻŌiwi to design and implement an effective monitoring strategy to gauge the effect of the stream restoration on the ecosystem services it provides. In addition to a monitoring strategy for the stream and associated buffer zone, the Heʻeia NERR will also provide technical assistance, help to establish baseline conditions, and planning functions to support these restoration activities being implemented by Kākoʻo ʻŌiwi.

Figure 11-1. Unrestored Heʻeia Stream invaded by California grass (*Urochloa mutica*)

(Photo courtesy of H.T. Harvey & Associates)

11.2.3 Kākoʻo ʻŌiwi—Upland Reforestation

The upland areas of the Heʻeia CDD are currently overgrown with nonnative invasive species. Some of the species currently found in the upland include java plum (*Syzygium cumini*), cat's claw (*Caesalpinia decapetala*), Cuba jute (*Sida rhombifolia*), koa haole (*Leucaena leucocephala*), and guava (*Psidium guajava*). Restoration of the upland areas will include the implementation of a hybrid ecosystem framework where there is a strong emphasis on enhancing the ecological characteristics of the area and improving ecosystem functionality. Using a hybrid ecosystem framework, restoration of the upland areas identified in Figure 11.1 will include removal of invasive non-native plant species, but allow for select non-native plants to remain, particularly those species that provide key forest structural attributes or important ecosystem services. Examples of these types of non-native plants include: Monkeypod tree (*Pithecellobium saman*), Gun Powder tree (*Trema orientalis*), Kukui (*Aleurites moluccanus*), Hau (*Hibiscus tiliceus*), Mango (*Mangifera indica*), and Kiawe (*Prosopis pallida*). Appropriate plant species will be determined upon a more thorough evaluation of existing vegetation, slope, and soil type. The Heʻeia NERR and its partners along with Kākoʻo ʻŌiwi will develop baseline assumptions around the reforestation and coordinate any anticipated human uses in the area and their interface with the Heʻeia NERR.

As the upland areas are to be restored with mainly native tree species, this may contribute to supporting a more resilient habitat for native and endemic fauna and flora. Given the potential for increased intensity and frequency of storms under climate change scenarios, a predominantly native forest is expected to capture rain and decrease the runoff that now occurs in the area that is overgrown with California grass and other invasive species. Kākoʻo ʻŌiwi is the main site partner for restoring the upland areas within the Heʻeia CDD, and the Heʻeia NERR will coordinate with them to design and implement an effective monitoring strategy to understand and assess the effects of the restoration on specific ecosystem services. In addition to developing a monitoring strategy for the upland forest, the Heʻeia NERR will also provide technical assistance, help to establish baseline conditions, and offer planning functions to support these restoration activities being implemented by Kākoʻo ʻŌiwi.

11.2.4 DAR—Coral Reef Restoration

Hawaiʻi DLNR's Division of Aquatic Resources (DAR) is implementing a program to control alien algae on coral reefs in Kāneʻohe Bay (DAR 2013). DAR uses a mechanical suction device called the "Super Sucker" (i.e., an underwater vacuum system) to remove invasive algae from Kāneʻohe Bay reefs (Figure 11-3). DAR then releases captive-reared sea urchins to graze on the remaining algae and thereby slow the regrowth of the infestation (Westbrook, et. al. 2015). Thousands of pounds of algae are removed from the bay including portions of the Heʻeia NERR and given to local farmers in the Kāneʻohe Bay area to be used as compost and fertilizer for their taro, sweet potato, corn, and flowering plant crops. The algae, high in nutrients, is used by farmers as a natural fertilizer to support healthy crop growth.

Both DAR and HIMB are potential partners for continuing this project in the bay. The reefs within the He'eia NERR that could have invasive algae removed from them are highlighted in Figure 11-3. In order to measure the effectiveness of algae removal on coral reef related ecosystem services and the success of sea urchin grazing to slow the growth of remaining algae, a monitoring strategy is needed. Working in coordination with DAR, HIMB, and other interested parties, the He'eia NERR will support the development and implementation of a coral reef monitoring strategy. In addition to the monitoring strategy for reef restoration, the He'eia NERR will also provide technical assistance, help to establish baseline conditions, and offer planning functions to support these restoration activities on the reefs. Resilience of the reefs to invasive algae is an important component of Kāne'ohe Bay's general health, and may help to inform climate change research regarding the spread of invasive species as conditions change in Kāne'ohe Bay and in other areas across the Hawaiian Islands.

Figure 11-2. Use of the "Super Sucker" removes invasive algae and helps restore coral reefs

(Photo courtesy of DAR)

11.2.5 DAR—Kāne'ohe Bay Patch Reef Coral Mitigation Bank

Hawai'i DLNR's Division of Aquatic Resources (DAR) is proposing to establish a coral reef mitigation bank on several patch reefs in Kāne'ohe Bay, including Patch Reef #10 and also using Patch Reef #9 within the proposed He'eia NERR boundary, as a control reference area (Figure 11-3) (USACE 2014). The coral mitigation bank will restore degraded patch reefs where invasive algae has taken over and caused partial or full mortality of live corals. As such, this activity would qualify as a NERR restoration activity within the He'eia NERR. As described above, the planned restoration activities at Patch Reef #10 will involve removal of the invasive algae by means of the Super Sucker and the release of sea urchins on the reefs to graze on residual invasive algae and prevent its regrowth. Patch Reef #9 will be used as a control reference site where no management or restoration action will occur and be used to evaluate the success of the restoration activities on Patch Reef #10. Sites besides Patch Reef #10 in Kāne'ohe Bay and the He'eia

NERR may be included in the mitigation bank, but first the mitigation bank proposal will need to be evaluated, and the site-specific plan publicly reviewed. The proposed treatment of bank sites is expected to result in significant restoration and benefit to the affected coral reefs.

Kāneʻohe Bay and portions of the Heʻeia NERR are ecologically suitable restoration sites because there is an identifiable threat of invasive algae to coral reefs, as well as established methods for restoring these areas. Removing invasive algae allows corals to regrow where partial mortality has occurred, and to recolonize previously occupied habitats. Although coral colonization may take several years, other native macroalgae or crustose coralline algae (a precursor to coral growth) may colonize these areas in the interim.

The resilience of the reefs to invasive algae is an important component of Kāneʻohe Bay's general health, and may help to inform climate change research regarding the spread of invasive species as conditions change in the bay and in other areas across the Hawaiian Islands. The Heʻeia NERR will support the efforts of DAR by coordinating with them and other partners to develop a monitoring strategy, providing technical assistance, helping to establish baseline conditions, and offering planning functions.

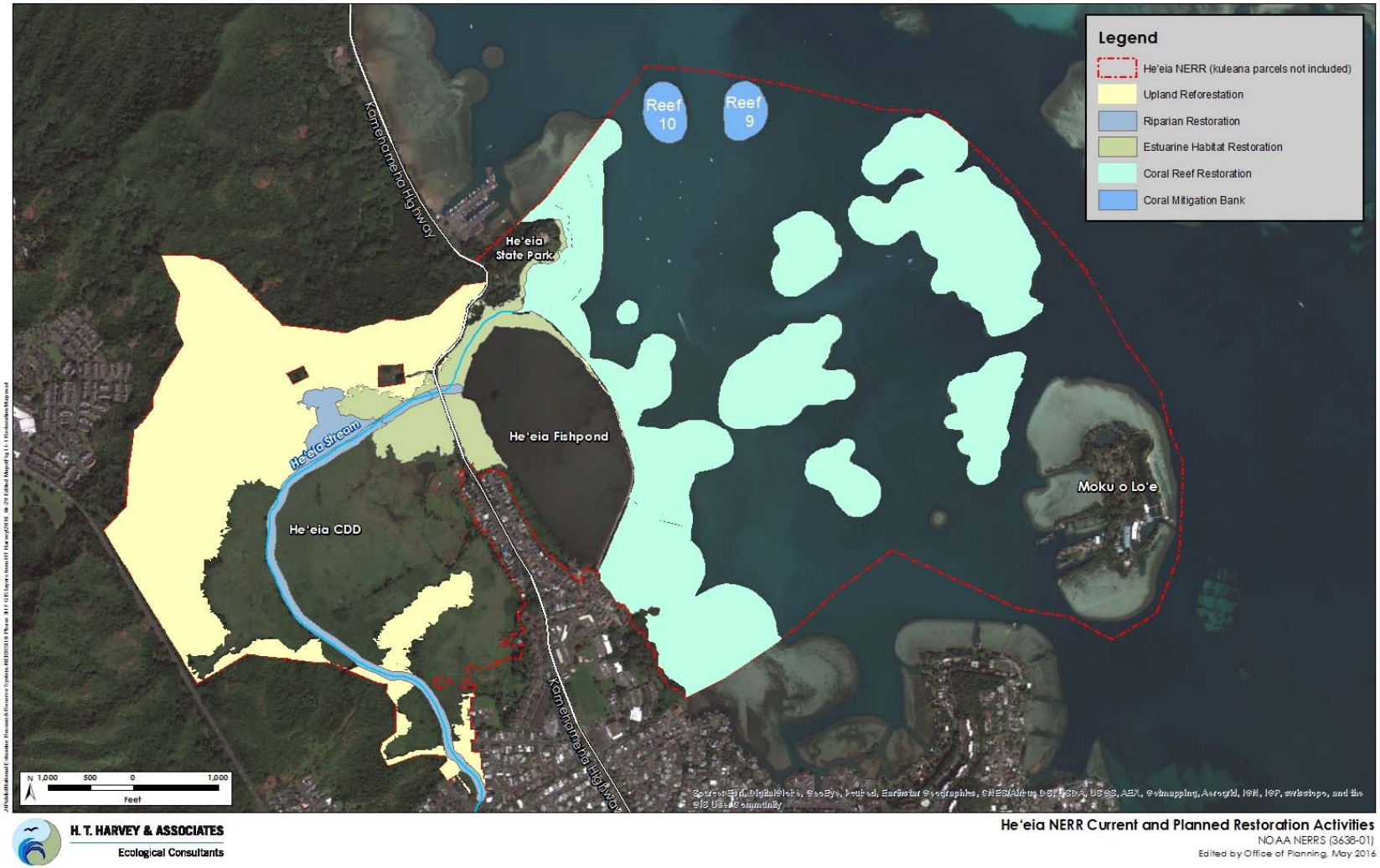

Figure 11-3. Kākoʻo ʻŌiwi and DLNR-DAR's current and planned restoration projects

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